June 7, 1934

Engineering News-Record

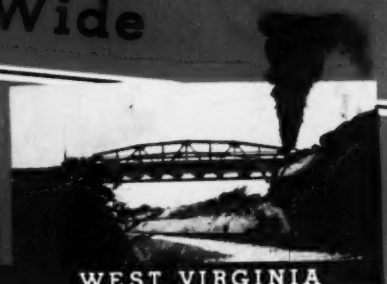
25 cents, $5 per year. McGraw-Hill Publishing Company, Inc.

Steel centering for second longest concrete arch bridge in the world, spanning 593 feet over Traneberg Sound in Stockholm, Sweden, being traversed into position for constructing the second of the twin ribs.

Bridge Protection with.. WROUGHT IRON BLAST PLATES goes Nation-Wide

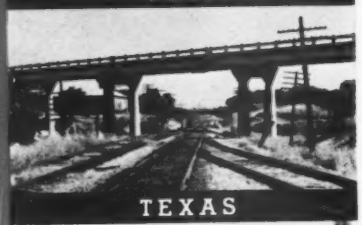
TENNESSEE

ILLINOIS



WEST VIRGINIA

OHIO



TEXAS

MASSACHUSETTS

ARKANSAS

RAILROADS and highways have united in a nation-wide fight to protect bridge structures with wrought iron blast plates. Unprotected bridges are being damaged by the combined effect of smoke, cinders and steam from locomotive stacks delivered at high velocities. The corrosion toll has been too heavy, so now wrought iron is being given the job of bridge protection.

This is logical—and it's sound engineering. Wrought iron's ability to take this punishment is conclusively demonstrated by the many wrought iron bridges constructed years ago and still in good condition.

Furthermore, wrought iron blast plates are easy to fabricate either by welding or riveting. They are not heavy nor costly and they withstand sudden and wide variations in temperature without cracking.

Illustrated here are some recent examples of the wide acceptance of wrought iron blast plates by both railroad and highway engineers. Ask a Byers Engineer to review with you the engineering data, service records and other facts used to back up these specifications—or write our Engineering Service Department. A. M. Byers Company, Established 1864. Pittsburgh, Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Los Angeles.

BYERS GENUINE WROUGHT IRON PRODUCTS

PIPE • WELDING FITTINGS • RIVETS • SPECIAL BENDING PIPE • BAR IRON
PLATES • SHEETS • CULVERTS • FORGING BILLETS • STRUCTURALS

STANDARD of QUALITY for 70 YEARS — BYERS 1864 — TODAY BETTER THAN EVER

ENGINEERING NEWS-RECORD

McGraw-Hill Publishing Co., Inc. Editorial and Publishing Offices: 330 West 42d St., New York

F. E. SCHMITT, *Editor* — WILLARD CHEVALIER, *Vice-President*

Editorial Staff
V. T. Boughton
W. G. Bowman
C. S. Hill

Chicago
W. W. De Berard

Editorial Staff
F. W. Herring
H. W. Richardson
J. I. Ballard

San Francisco
N. A. Bowers

CONTENTS FOR JUNE 7, 1934

VOLUME 112 NUMBER 23 COPYRIGHT, 1934

Record-Span Concrete Arch in Stockholm....727

Laboratory Tests of Goldbeck Cells.....730
BY W. H. SEAQUIST

Washington State Planning Council Program..732

Modernizing an Activated-Sludge Plant.....733
BY ERNEST W. WHITLOCK

Stabilized Soil-Bound Road Surfaces—II....738
BY W. R. COLLINGS and L. C. STEWART

Model Traffic-Safety Acts.....744

Letters to the Editor.....746

Editorials 748

Current News 750

The Business Side of Construction.....756

In the News:

WATER-SUPPLY DEVELOPMENT to aid farmers and others in the drought-stricken areas are planned by FERA. Wells and small impounded supplies are contemplated. In the meantime the Weather Bureau describes the drought as the worst on record, both in area covered and in water deficiency.

A 17-MILE DREDGING JOB was completed last week. Ceremonies at Jones Beach State Park on the east shore of Long Island opened a boat channel of that length from which some 30,000,000 cu.yd. of sand had been pumped into roadway fill for the park's boulevard system.

THE NEW HOUSING PROGRAM continues to encounter rough sledding in Congress. Principal opposition comes from the U.S. Building and Loan League and other real estate bodies which object to the proposed reform of mortgage practices.

DAM BUILDING on the Columbia River is again high-spot news: the army engineers awarded the Bonneville spillway dam contract to the Columbia Construction Co., Reno, Nev., on a low bid of $8,972,650, and the Bureau of Reclamation is to open bids June 18 for the Grand Coulee project. The Columbia Construction Co. is said to be composed of five of the firms in Six Companies Inc., builders of Boulder Dam.

THE CONSTRUCTION CODE MANUAL to be published by the Construction League of the United States, Washington, D. C., will be ready for distribution June 15.

MUNICIPALLY-OWNED UTILITIES in the state of Washington must pay taxes on gross revenues under the state business tax law. The decision was rendered by the state supreme court. There are 15 power and light plants and 139 water systems that are affected.

DESPITE NRA RULINGS that none but unskilled labor rates may be set in codes, the movement to establish minimum rates for engineers and engineering assistants continues to move forward. The New York County and Kings County chapters of the New York State Society of Professional Engineers list $100 per month for the lowest grade of subprofessional work and $200 for an engineer with the training required for a license in New York State.

TVA, following out its policy of not building competing electric utility systems, except as a last resort, has purchased the properties of the Mississippi Power Co. in nine counties in Mississippi.

NOT OVER $500,000,000 of the $1,178,270,000 directly appropriated in the Deficiency Appropriations Bill, introduced into the House on June 2, is to be spent for non-federal public work, but as the bill authorized the RFC to purchase bonds of cities that have received allocations of PWA funds the amount actually made available for such public work is theoretically much larger. The bill definitely allocates $111,000,000 for highway work and $65,0000,000 for federal buildings.

PWA REPORT: More than half a billion dollars worth of non-federal projects are under construction, involving 664 jobs and slightly over half the total cost of all approved non-federal projects. Also 263 projects are ready to go into construction, and bids are being advertised on 323 more; 137 projects are finished. Direct employment has passed the 400,000 mark.

In This Issue:

LONGEST CONCRETE ARCH but one is the new bridge that the Stockholm Harbour Board is bringing to completion across Traneberg Sound in Sweden. Its span of 593.5 ft. is more than 100 ft. greater than our longest and only 20 ft. short of the arches built by Freyssinet at Brest, France.

TEN YEARS OF USE of the familiar Goldbeck cell, for measuring soil pressures, demonstrated two things: first, that the instrument is very practical; and, second, that its accuracy could be increased by certain changes in design. These changes have been made, and laboratory tests indicate that the cell is improved, and also indicate certain desirable modifications in the manner of use.

HAGERSTOWN, MD., one of the first cities in the United States to use the activated-sludge method of sewage treatment, has completed a major program of modernization. The remodeled plant is of particular interest on account of grease separation by compressed air and the conversion of undigested solids to inoffensive sludge by vacuum filters.

THE SECOND ARTICLE on stabilized soil-bound road surfaces records a series of carefully conducted traffic tests on roads of various soil mixtures subjected artificially to rain and warm winds.

Coming Articles:

A CENTRALIZATION of hydraulic research, probably unequaled elsewhere in the world, has been undertaken by Soviet Russia in the Leningrad laboratories of the Scientific Research Institute of Hydrotechnics. An article in our next issue describes the new research organization, outlines its procedure and cites a number of its outstanding studies and improved laboratory methods. The laboratory is a part of the Soviet program, in preparation for the second Five-Year Plan for industrial development, to conduct an extensive program of basic research, rationalization and standardization, shown to be necessary from experience with the first Five-Year Plan.

Built for service, beautifully, of terrazzo

This floor is in a post-office. Conditions: heavy daily traffic, constant wear under careless feet—shuffling, scraping, grinding. Requirements: durability, good appearance, easy and inexpensive maintenance. The floor is built of fine terrazzo, made with Atlas White portland cement. It's appearance speaks for itself. It shows clearly how a *white* portland cement matrix allows exact color control, blending or contrasting with the marble chips precisely as desired. As to wearing well, and as to economy of up-keep, these qualities are attested by the records of similar floors in buildings throughout the country. For details, see our catalog in Sweet's, or ask any terrazzo contractor. Or write Universal Atlas Cement Co., *Subsidiary of United States Steel Corporation*, 208 So. La Salle St., Chicago.

This fine terrazzo floor in the Sacramento post-office was made with Atlas White portland cement. Installed by the California Terrazzo Marble Co. of San Francisco. Starks & Flanders of Sacramento were the architects.

ATLAS WHITE PORTLAND CEMENT

plain and waterproofed

UNIVERSAL PORTLAND CEMENT ATLAS PORTLAND CEMENT

ENGINEERING NEWS-RECORD

New York, June 7, 1934

FIG. 1—TRANEBERG SOUND BRIDGE in Stockholm, Sweden, includes the second longest concrete-arch span in the world—593.5 ft.

Record-Span Concrete Arch Built in Stockholm

New Traneberg Bridge includes a twin hollow-rib span of 593.5 ft.—Deck 90 ft. wide accommodates two electric railway tracks, a roadway, sidewalks and bicycle lanes

A REINFORCED-CONCRETE arch bridge with a span length second only to that of the arches of the Plougestel Bridge near Brest, France, will be opened to traffic in Stockholm, Sweden, about Sept. 1. Crossing Traneberg Sound, an arm of Lake Malaren, the bridge connects the main city with the western suburban area and replaces an old pontoon bridge of considerable size. The new Traneberg Bridge is located about 400 ft. north of the pontoon bridge and has a total length, including viaduct approaches, of 1,900 ft. The arch over the waterway has a theoretical span, center to center of supports, of 593.5 ft. and a clear span between abutments of 585 ft. This compares with a 612-ft. theoretical span for the Plougestel arches. The rise of the Traneberg arch is 88.5 ft. The bridge has an over-all width between balustrades of 91.2 ft., which includes a 39-ft. roadway, two 8-ft. sidewalks and two 4-ft. bicycle tracks, as well as a 28-ft. width devoted to two electric railway tracks. The twin arch ribs of the bridge were poured on steel arch centers erected on temporary skewbacks under one rib and then moved sideways into position under the other rib. Erection, therefore, was quite as notable as the design. The bridge was designed and construction has been carried out under the supervision of the engineering department of the Stockholm Harbour Board.

The arch span

As shown in the accompanying illustrations, the arch span consists of twin ribs separated about 20 ft. between the inner edges. Each rib has a width of 29.5 ft., a depth of 16.4 ft. at the abutments and 9.8 ft. at the crown, and is designed as a hollow box of three cells. The slab thicknesses at the crown are 18 in. for the top slab and 19½ in. for the bottom slab. The side walls are 19½ in. thick, and the division walls 16 in. thick. The dimensions of the slabs and vertical walls are increased toward the abutments. The center cell in each arch is continued through the concrete abutments. A water main will be housed in the center cell, and the side cells will accommodate a gas main and electric conduits.

The ribs are not very heavily reinforced, since tension will occur only occasionally, and then only in the lower slab at the abutments. In each rib there are 108 round bars, ⅞ in. in diameter. In addition, there is some reinforcement of the same size bars at right angles to

---

The information upon which this article is based is taken from a paper read before the German Concrete Society by Major Ernst Nillson, chief engineer of bridge construction for the Stockholm Harbour Board. The data and illustrations were furnished by Major Nillson. —Editor.

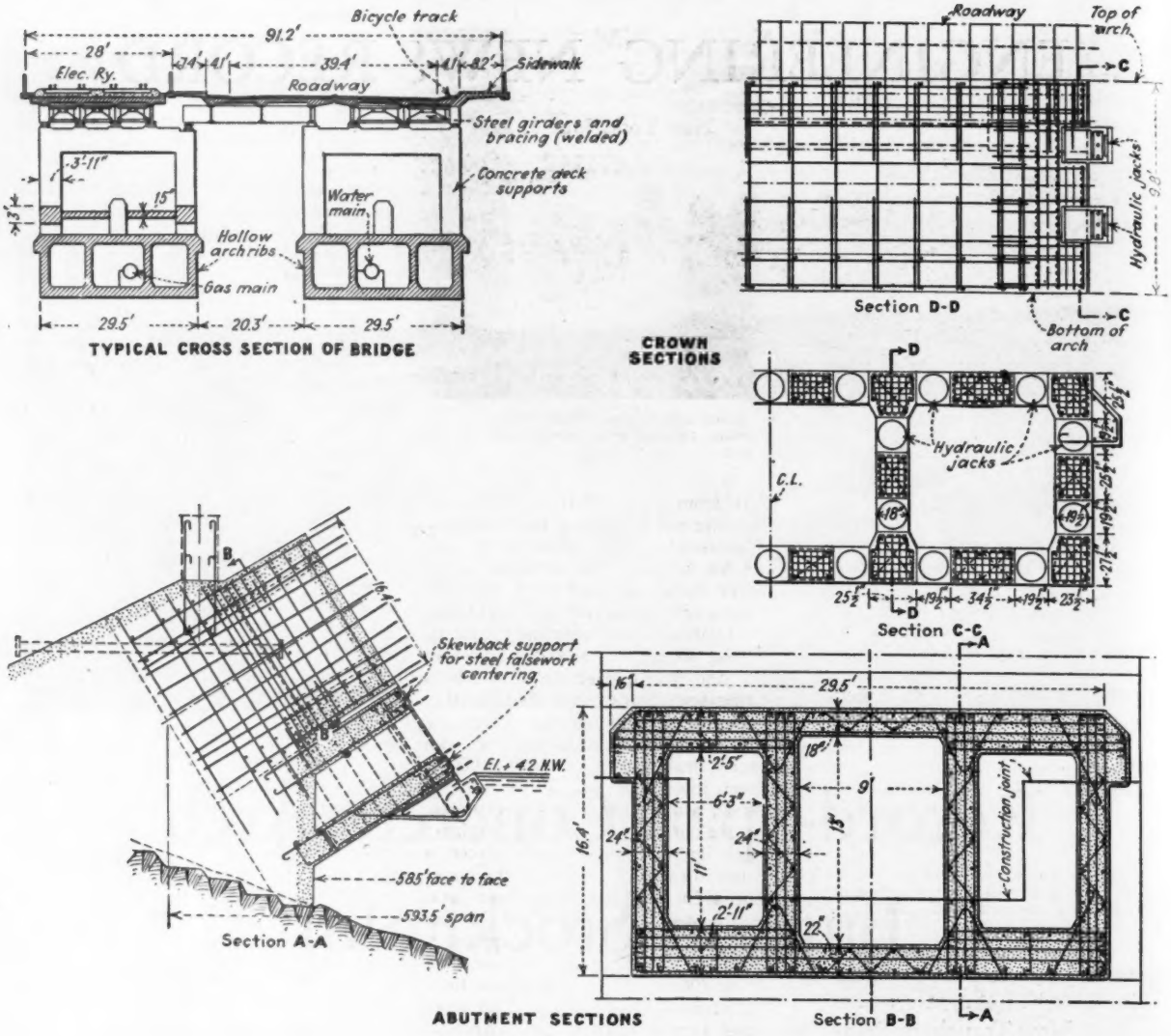


FIG. 2—TWIN HOLLOW RIBS are one feature of the new concrete-arch bridge over Traneberg Sound. Hydraulic jacks inserted at the crown were used to lift the ribs from the centering and to apply an initial bending moment.

the main bars. Extra reinforcement was used at the crown to take care of decentering stresses. On an average the steel reinforcement is about 3.75 lb. per cu.ft. of concrete.

The deck over the arch is carried, except near the center of the span, on concrete cross-walls spaced 42½ ft. apart. Some of these cross-walls are hinged at the base, to permit movement with deck expansion and contraction. At the center of the span for a length of about 180 ft. the deck is carried on longitudinal walls flush with the faces of the arch ribs.

The deck framing is of steel girders (continuous over the walls), cross-beams and stringers, framed in. All field connections are arc-welded. The vehicle roadway consists of a concrete slab covered in turn with membrane waterproofing, a thin protective coat of concrete and thin coats of asphaltic concrete and sheet asphalt. The railway slab is similar, except for the asphalt, and the tracks are laid on a 20-in. layer of stone ballast. The deck is divided into two units along a longitudinal center joint, since each arch rib is designed to act separately under live load and temperature.

Erection centering

The falsework employed for the construction of the arch ribs consisted of a 564-ft. copper-manganese steel arch made up of four riveted steel-plate girders 94 in. deep spaced 8 ft. 4 in., 7 ft. 2 in. and 8 ft. 4 in., respectively. Centering spanning the full channel width was mandatory, water depth at the center being 50 ft. and rock depth 100 ft. This steel centering was designed as a hingeless steel arch. Abutments were provided by temporary concrete skewbacks cantilevered out from the abutment.

The steel arch ribs were fabricated in sections 36 ft. long and transported by barge to a wharf about 1¼ miles from the bridge site. At this wharf the sections were riveted into half spans, and these half spans were assembled in units of two ribs each, in which form they were brought to the bridge site on a small floating dock, passing, with very close clearance, through a swing span in the old pontoon bridge. A steel tower was then built up on a float and moored in the center of the channel, to act as a support for joining the ends of the half arches. The four half spans were then maneuvered into position between the abutments and the floating erection tower, and the skewback end of each arch was attached to the abutment. The crown end of each centering unit was suspended from the tower by link plates and raised to position by means of hydraulic jacks set on top of the tower. When the four half spans had been lifted to the correct height, they were coupled together with a temporary ball link at

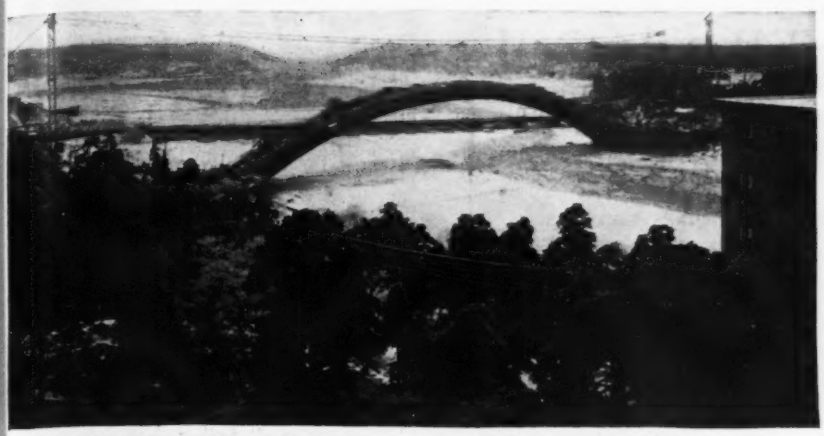


FIG. 3—CABLEWAY handled forms and concrete during construction. Much of the arch concrete was poured in winter. The pontoon bridge, replaced by the new bridge, is visible beyond the arch.

the crown; after adjustments had been made with hydraulic jacks at the abutments and the final bearings built in, the arches were riveted together at the crown. Finally, the bracing between the two sets of units was installed, to provide the complete assembly of four hingeless steel arch ribs.

Concreting the arch

In concreting the ribs of the arch, the lower slab and the side walls were placed first, followed by the inner partition walls and finally the top slab. Concrete was poured in sections varying in length from 23½ to 28 ft., and in a suitable order for equalizing the loading on the centering. Keys about 4 ft. long were left between the sections, to take care of shrinkage, and were not filled until the other concrete was eight days old. Timber forms were used, and the concrete, which was mixed at a central plant and transported to the job in rotating-body trucks, was distributed by a cableway located on the center line of the bridge. The cableway, of 4-ton capacity, had a span of about 1,000 ft. between towers 180 ft. high.

FIG. 4—CENTERING consisted of four hingeless steel-arch ribs. View shows centering being traversed from under a completed concrete rib into position for pouring the second rib.

As an aid in releasing the centering from the first completed rib, eighteen 330-ton hydraulic jacks were placed in position in recesses formed in the crown of the arch. By operating these jacks the arch crown was lifted 6½ in. and opened 4⅞ in. The pressure applied to obtain these movements was about 6,000 tons, or 700 tons in excess of the horizontal stress due to the dead load when the arch is in normal position. Application of this pressure caused the arch concrete rib to be raised from the steel centering on a length of 65 ft. at the crown and 82 ft. at the abutments. According to Carlson electric strain gages installed in the ribs at the abutments (and left in for permanent use), the stresses in the top slab increased from 0 to 700 lb. per sq.in., and in the bottom slab from 0 to 42 lb. per sq. in.

After the steel arches had been unloaded, they were lowered away from the concrete arch by eight hydraulic jacks placed at the abutments. They were then moved sideways on rollers to a position under the second rib location. The temporary steel arches, together with the timber form falsework, weighed about 1,200 tons.

Two months after the centering under the ribs had been struck, (the ribs during this interval having come down about one half of the super elevation of 6½ in.) a negative bending moment was applied, to compensate for the increased stresses due to the weight of roadway, live loads and to temperature variations. This bending moment was obtained by using four additional hydraulic jacks at the crown section, bringing the total number of jacks up to 22. The moment was produced by operating the jacks so as to exert different pressures at the top and bottom portions of the rib respectively. The bending moment was estimated at 10½ million ft.-lb. When it had been obtained, the crown joint was filled with rich mortar, which was allowed to set for 14 days. The jacks were then run down, removed, and the recesses filled with mortar.

The concrete used in the arch ribs and abutments was a 1:2.6:2.5 mixture, giving a 7-day strength of 3,100 lb. per sq.in., a 28-day strength of 6,100 lb. per sq.in., and a 90-day strength of 6,400 lb. per sq.in. The permissible working stress was 1,400 lb. per sq.in.

About 28,500 yd. of concrete were required for the Traneberg Bridge. In addition, there are 1,300 tons of steel reinforcement and 1,300 tons of structural steel, in the deck. The cost of the bridge was $5,300,000.

FIG. 5—DECK 90 FT. WIDE accommodates roadway, sidewalks, bicycle lanes and two electric railway tracks.

Accuracy of Goldbeck Cell in Laboratory Tests

Familiar pressure cell as recently improved gives accurate results when subjected to precise laboratory testing methods

By W. H. Seaquist
Mechanical Engineer, American Instrument Co., Washington, D. C.

DURING recent years there has been a wide and varied use of the Goldbeck soil-pressure cell to measure pressures in soils. In this time hundreds of cells have been put in service, and some have been in continuous use for more than ten years. At intervals the question has been raised as to the accuracy of this method of measuring pressures, particularly in granular and highly compacted materials. The early tests and use of the cell were described by Goldbeck. in the *Proceedings*, A.S.T.M., Part II, 1917, and in *Public Roads*, for August, 1920. Experience gained from the cells in service suggested some changes and refinements in the design which would give a greater degree of accuracy. A further investigation was undertaken to determine the effect of these changes, using recently developed instruments of high precision to measure the results.

The basic principle involved in the Goldbeck cell is to balance the earth pressure on a piston against a controllable air pressure and note the air pressure at the instant a piston has moved an extremely small distance to break an electric circuit containing a lamp.

From Fig. 1 it is seen that the cell consists of a base A in the center of which is an electric contact button F insulated from and clamped solidly to the base; a piston B, 10 sq. in. in area, which rests on the button; a thin bronze diaphragm C, which covers the annular space between the piston and ring D and so arraged that it offers no restraint during the small movement of the piston and maintains an internal piston area of 10 sq. in. The outer edge of the diaphragm is clamped between the base and ring D, which centers the diaphragm and piston assembly in the base. This ring serves as a backing for the unclamped portion of the diaphragm and holds it in a true plane against the air pressure. The bore of this ring is made to receive a specially designed rubber seal ring, which prevents the entrance of moisture and soil between the piston and the ring. The seal ring does not restrain the piston to any appreciable amount. The inner edge of the diaphragm is clamped to the piston with ring E, which serves as a stop to limit the travel and tipping of the piston to about 0.005 in.

A pipe ¼ in. in diameter connected to the cell is run to a portable operating case at the surface. The electric wire from the contact is led through the pipe to connect in a suitable battery and lamp circuit, the pipe itself serving as the return side of the line to the cell. The portable operating case contains a small tank of compressed air, the control valves, pressure gages and the battery and lamp circuit. The operating mechanism is seen to the right in Fig. 2.

Changes in design

The principal object in making the changes in design was to reduce, if possible, the amount of piston displacement necessary to break electric contact in the cell, and thereby reduce the error of the cell to a minimum. The new design is basically the same as in the old cell. The principal changes are:

1. The outside protective coating, interposed between the soil and the cell, consisting of 0.002-in. sheet brass, cheesecloth and asphalt, has been eliminated. As a substitute, the cell is made of a non-corrosive alloy, and a rubber seal ring closes the space between the piston and the body of the cell, allowing the piston surface to come in direct contact with the soil.

2. The piston is of one piece, so that solid metal is between the soil load and the contact button. The diaphragm is clamped to the piston with a ring instead of a disk.

3. The contact button is clamped down tight in the base with thin mica insulation, thus eliminating the yielding found in buttons seated in bakelite cement.

4. The displacement and tipping of the piston has been limited to 0.005 in. to protect the diaphragms against injury or rupture. Tipping greater than this causes serious error due to changes in the internal effective area of the piston.

5. The cell parts are heavier and made of harder material to reduce displacement due to bending and compression of the parts.

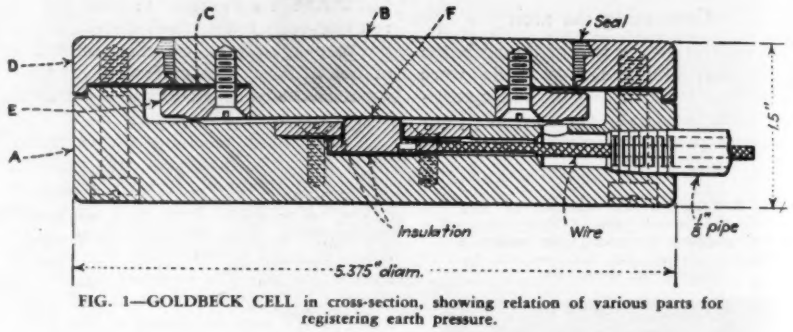


FIG. 1—GOLDBECK CELL in cross-section, showing relation of various parts for registering earth pressure.

Preliminary tests

The preliminary tests were made in a Southwark-Emery testing machine, with the cell seated on an 18-in. column of red clay held in a 12-in. pipe. The size of the testing machine limited the amount of clay that could be placed between the machine and the cell. It is to be appreciated that this is a severe test, as the testing machine and the small body of clay is a very rigid system. Very rarely is the cell used to record pressure in small volumes. This method can be made to duplicate actual soil conditions in a general way by varying the moisture in the soil and the degree of tamping and precompression. The load on the testing machine increases as air is introduced into the cell to raise the piston enough to break the lamp circuit. This increase in load is, therefore, an indication of the accuracy of the cell under these extremely severe conditions.

These tests were run with applied loads up to the capacity of the cell. The compactness of the soil was varied from slight tamping to a precompression of about 125 lb. per sq. in. on both moist and dry soil. At loads below 50 lb. per sq. in. on moderately compacted clay the increase in load, as indicated by the testing machine, was in no case more than 1½ lb. per sq. in., or less than 3 per cent. As the loads reached the maximum and the clay was dry and highly compacted, the increases in load were nearly 10 per cent. On moist, lightly tamped clay, with loads of 20 lb. per sq. in., the increase was only 0.5 per cent.

This method of testing does not permit an accurate determination of the effect of load on internal piston area, as the load tends to change during a test due to the yielding of the clay. Nor does it permit a measurement of

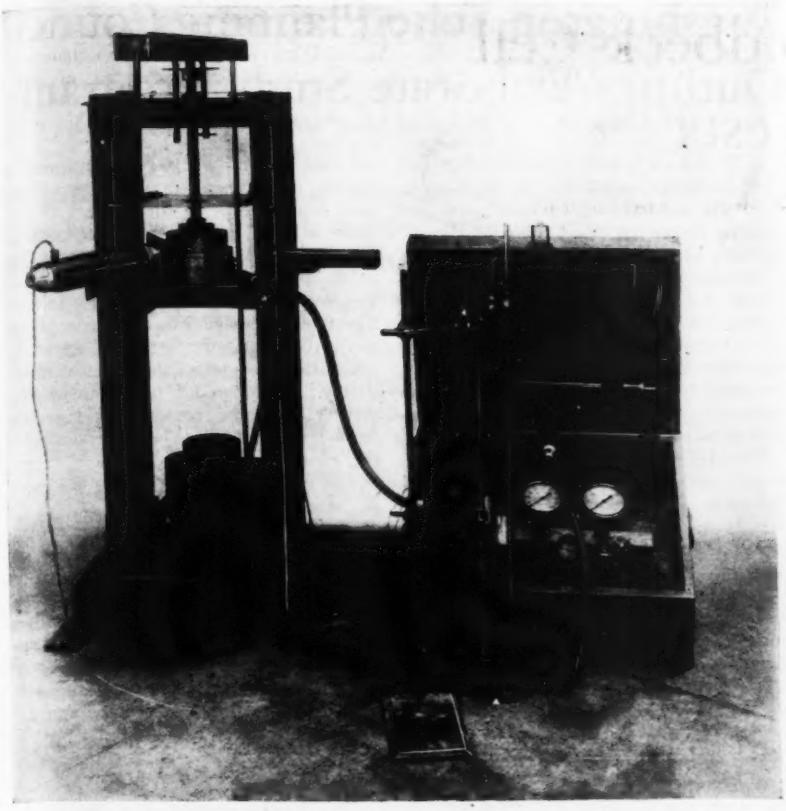


FIG. 2—TEST APPARATUS as arranged for determining accuracy of pressure measurements of Goldbeck cell.

the extremely small piston displacements to break the electric circuit. The relation between piston displacement and load has an important bearing on accuracy and is a measure of the rigidity of the cell assembly. As the piston has an area of 10 sq. in. in contact with the soil, the internal or "air" area under the diaphragm must have the same value in order that the air pressure, as shown by the gage, will be a direct measure of the soil pressure in pounds per square inch. Obviously this area must remain constant and independent of load.

More accurate test procedure

Therefore, a new method of testing was developed, whereby the load could be held constant during a test and the piston displacement measured within very close limits. The device is shown in Fig. 2. The cell is placed between and in the center of two heavy machined steel disks. The lower disk rests on a platform set level with leveling screws at the floor. The upper disk is centrally loaded through a threaded 1-in. rod or post held vertical with two thin flexible plates fastened to the frame. The loading platform and suspension rests on a 1-in. steel ball seated in the upper end of the post. The post can be turned in the nuts fastened to the flexure plates until, with the cell in place, the two flexture plates are exactly plane. This construction allows vertical movement of the post without appreciable resistance from the flexure plates when the motion is small and prevents horizontal motion or tipping.

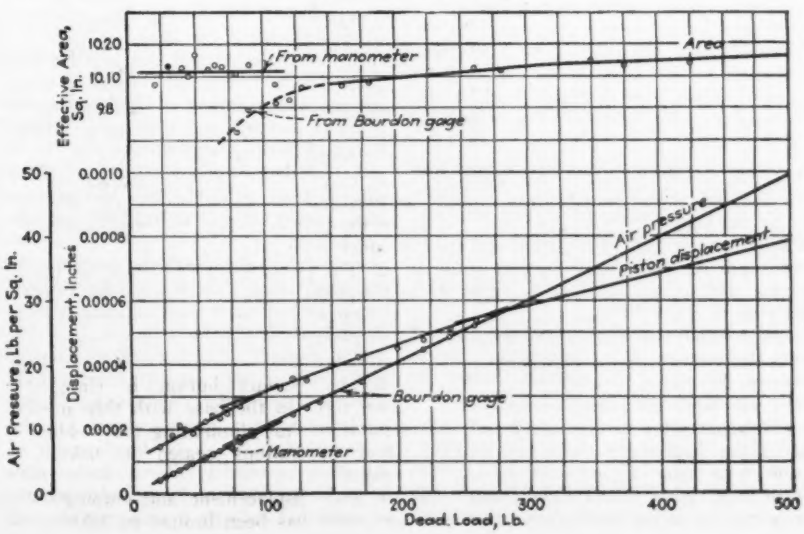
Three Tuckerman strain gages (as described in the report of the arch dam committee, A.S.C.E. May, 1928) span the space between the two disks and are located 120 deg. apart around the disks. Any vertical motion whatever is thus recorded on one or more of the gages. An average of the three readings is a measure of the motion at the center. The Tuckerman autocollimator (see *Tuckerman Optical Strain Gage Bulletin*, American Instrument Co., Washington, D. C.) is shown in position to take a reading on one of the gages. Motion of the piston is determined with an error of less than 0.00002 in. All parts of the rig supported on the cell and all weights placed on the platform are weighed to the nearest 0.01 lb.

Results of tests

The curves in Fig 3 were plotted from data taken in a test with the cell mounted as shown in Fig. 2. Readings of piston displacement and air pressure to break electric contact were taken for each load value from 20 to 500 lb. A mercury manometer was used to record air pressures for loads up to 110 lb. Above this a large Bourdon test gage, calibrated at the National Bureau of Standards, was used. The errors in air pressures are probably not over 0.2 lb. per sq. in.

The displacement found by this method is a summation of all changes in shape or position of the cell parts as air is introduced to break contact. Obviously there is some change in shape as the load inside the cell changes from a concentrated load on the contact button to a uniformly distributed air-pressure load. At a load of 500 lb. it is seen that the total displacement is less than 0.0008 in. Each point shown on the curve is a displacement just sufficient to break contact for the corresponding load. The air-pressure curve shows the relation between load and pressure to break contact. At the lower end of the curve between 70- and 110-lb. load an

FIG. 3—TEST RESULTS of Goldbeck pressure cell as determined by precise laboratory tests.



overlapping is seen. Bourdon gage readings are about 0.3 lb. per sq. in. high at 70 lb. and diminish as the load rises. Mercury manometer pressures were consistent within 0.1 lb.

The upper curve is a plot of the effective or air area of the piston and diaphragm. This area is determined by dividing the load by the corresponding air pressure to break contact. At low loads, manometer readings give areas slightly above 10 sq. in. and gage readings show area below 10 sq. in. As the load approaches 500 lb., the effective area increases slowly to about 10.1 sq. in. The average variation in area is well within 1 per cent. Stated in another way, the air pressure to break contact will be equal to the applied load in pounds per square inch, or to one-tenth of the total load, with an average error of less than 1 per cent.

As stated before, in this method of testing, the displacement to break contact occurs while the pressure cell is under constant load. This obviously is not exactly the case when the cell is buried in earth; that is, any motion in the cell tends to compress the soil and thus slightly increase the force against the cell. The soil pressure at the time of contact break is, therefore, slightly higher than the actual soil pressure. But the displacement to break contact against soil pressure will be but very little greater than the displacement to break contact against constant load. Therefore, a measure of the displacement under constant load is a very close approximation of the displacement when the cell is buried in earth.

Conclusions

Considering these known displacements and the corresponding constant loads in comparison with the increase in loads in the earlier tests on the testing machine with hard clay, it is found that for each 0.0001 in. of piston displacement there is an increase in load of about 1 per cent; and considering the severity of the laboratory soil-pressure loading test, it seems reasonable to assume that the accuracy of the soil-pressure cell, when used in service, will be even greater than that indicated by the laboratory investigation. The tests have shown that:

1. The cell must be very rugged and assembled with great care. Misalignment of the diaphragm by as little as 0.0005 in. introduces a large error in piston area.

2. Each cell should be calibrated against a dead load.

3. The lamp in the circuit must be of the low-current type to prevent errors due to arcing at the contact button as the circuit opens.

Acknowledgment is made of the assistance and suggestions given to the writer in this investigation by A. T. Goldbeck, who was the originator of this method of measuring soil pressures.

Washington State Planning Council Outlines Elaborate Study Program

AN EXTREMELY comprehensive program of study to investigate the natural, agricultural and industrial resources of the state of Washington has been laid out by the Washington State Planning Council, which was established by legislative act during the 1934 special session. Under the direction of an executive secretary the council will correlate its study with the work to be done by the regional and national planning boards and the various state departments.

The law provides for a council of nine members to be appointed by the governor. The members serve without compensation, but are paid necessary expenses. The board is a continuing body with three members appointed for a term of six years, three for a term of four years and three for two years, with the six-year term becoming standard at the expiration of the initial periods. The council selects one of its members as chairman and is empowered to employ an executive secretary and such technical and clerical help as may be necessary. R. K. Tiffany, consulting engineer, Olympia, has been named executive secretary.

Specific fields for study provided by the act are intended to include the natural, agricultural and industrial resources of the state, and include the following: (1) communication and transportation facilities, (2) fisheries, (3) forests, (4) industrial and commercial establishments, (5) lands, (6) mines and minerals, (7) rivers and harbors, (8) wild life and recreation facilities, and (9) watersheds furnishing water for irrigation and domestic use.

The act provides that the council shall have the power and the duty:

1. To make inquiries, investigations and surveys concerning the resources of all sections of the state.

2. To assemble and analyze the data thus obtained, and to formulate plans for the conservation of such resources and the planned and systematic utilization and development thereof.

3. To make recommendations, from time to time, as to the best methods for such conservation, utilization and development.

4. To cooperate with the federal government, other states and the departments of the state government, relative to planning and conservation.

The council is authorized to prepare and perfect a state master plan for flood control, state public reservations, sites for state public buildings and for the economical and orderly development of the state resources. This master plan is to be adopted and can subsequently be amended only by a majority vote of the council, and will serve as a guide in making recommendations to the officers and departments of the state. Whenever a state improvement is contemplated, the agency in charge of the work is to request the planning council to report on this improvement; in case the state agency carries out the improvement at variance with the report of the council, this agency shall file a report that will be open for public inspection, setting forth the reasons for rejecting or varying from the recommendation of the council.

The council is authorized to hold public hearings and compel the attendance of witnesses. Following its organization, the council, acting through an executive committee, set up an advisory technical committee consisting of the chairmen of the various study divisions. These divisions of the program of investigation to be undertaken are listed in the following table, with the subdivisions thus far proposed for study.

AGRICULTURE
- Grain farming
- Truck farming
- Horticulture
- Animal husbandry
- Subsistence homesteads
- Land erosion

COMMERCE AND INDUSTRY
- Manufacturing
- Foreign trade
- Marketing
- Banking

EDUCATION
- Reorganization
- Revenues
- Tax support
- Coordin. higher & lower units
- Broadened curricula

FISHERIES
- Scientific research
- Sport and fresh-water fisheries
- Commercial fisheries

FORESTRY
- Lumber production
- Forest management
- Silviculture
- Forest products
- Fire prevention
- Logging
- Watershed and erosion control

LABOR
- Statistics
- Organizations
- Unorganized labor
- Gov. agencies
- Legislation
- Employment

LAND CLASSIFICATION AND USE
- Soil analysis
- Economic uses
- Climatology
- Ownership and tenantry

MINERAL RESOURCES
- Metals
- Coal
- Petroleum and gas
- Ceramics
- Non-metals

POWER
- Resources
- Generating stations
- Transmission lines
- Distrib. systems
- Industrial loads
- Utilities

PUBLIC FINANCE
- Taxation
- Government reorganization

PUBLIC WELFARE
- Population and migration
- Public health
- Social welfare
- Recreation

RIVERS AND HARBORS
- Flood control
- Breakwaters and seawalls
- Dredging
- Canals and locks
- Docks and terminals

TRANSPORTATION
- Highways
- Railways
- Motor buses
- Waterways
- Airways
- Pipe lines
- Ports and terminals

WATER RESOURCES
- Precipitation
- Streamflow
- Stream profiles
- Storage
- Water supply
- Subsurface waters
- Irrigation

ADVANCE PLANNING OF PUB. WKS.
- Highways
- Buildings, etc.
- Municipal and county Public Works

Modernizing and Enlarging an Activated-Sludge Plant

Sewage-treatment facilities at Hagerstown, Md., extended by constructing grease chamber, preliminary settling tanks and diffused-air aeration tanks—Mechanical dewatering of undigested sludge proves highly efficient

By Ernest W. Whitlock
Fuller & McClintock, Consulting Engineers, New York, N. Y.

HAGERSTOWN, MD., one of the early cities in the United States to use the activated-sludge method for treatment of its sewage, completed in May, 1933, a program of major extensions and betterments to its sewage-treatment works originally constructed in 1924-'25. The remodeled plant is of particular interest on account of grease separation by compressed air and the conversion of undigested solids to inoffensive sludge cake by vacuum filters.

The plant effluent is discharged into Antietam Creek, which has a drainage area of 190 square miles and dry-weather flows often as low as 20 to 30 cu.ft. per sec. A dam located about a mile below the plant outfall forms a pond about 80 ft. wide and 8 ft. deep, which extends upstream beyond the treatment works. To avoid unwholesome conditions in the stream, a high degree of treatment is necessary.

The original plant

Before improvement, the plant included coarse bar screens, a revolving fine screen, grit chambers, aeration by a novel and experimental type of mechanical aerator and final sedimentation. The screenings and sludge were dried, after heavy lime treatment, on open sand beds, and the dried sludge was then spread on city-owned farm land.

The original aeration equipment was of the turbo-aerator type placed in the center of deep rectangular tanks. With various changes, including application of compressed air through a row of plates placed around the equipment, it was operated intermittently each summer until the fall of 1929, when its use was abandoned because of failure to obtain satisfactory results. Another aerating device of similar type but of different make was installed for trial in each of the two tanks in 1930, and after extensive trials and tests, it was removed by the manufacturer in 1931 because it did not prove economical or satisfactory for local conditions.

During the eight years of operation of the original plant the disposal of undigested limed sludge on the open beds was only moderately successful. The beds, which were constructed without lateral underdrains, became clogged, and it was necessary to dispose of a substantial portion of the sludge by pumping directly to ditches and lagoons.

These circumstances and increasing sewage flow necessitated extensive improvements. Fortunately, the original structures were well built, in excellent condition, and their arrangement was such that the greater portion could be used to excellent advantage in providing a modern up-to-date treatment plant at a very reasonable total cost.

Design data

The plant is designed for an average flow of 4 m.g.d., based on an average flow of 100 gal. per capita daily from a connected population of 40,000 people, predicted for 1945. Complete treatment is given to all flows, however, up to 6 m.g.d. Full preliminary treatment is provided for a flow of 8 m.g.d., and flows in excess of 6 m.g.d. are bypassed after passing through the preliminary tanks.

The data in the following tabulation were used in the design of the plant, based on an average rate of flow of 4 m.g.d.

Grease-separation tanks, average minutes detention	4
Preliminary tanks, average hours detention	1
Aeration tanks, average hours detention (sewage plus 25% return sludge)	6
Air provided at average flow, cu.ft. per gal.	1.2
Air pressure, lb.	7
Final tanks, gal. per sq.ft. daily	800
Dry solids in sewage, lb. per capita per day	0.2
Per cent moisture of mixed sludge	97
Minimum sludge filtering rate, dry-sewage solids per hr.	1.0

Overflow chamber

In the main 54-in. trunk sewer about 300 ft. above the plant a new overflow chamber, with a drain to the creek, has been provided. The elevation of the weir is such that at least 8 m.g.d. will pass to the plant before any overflow takes place, although for emergency purposes a gate is provided, so arranged as to divert the flow at any desired rate.

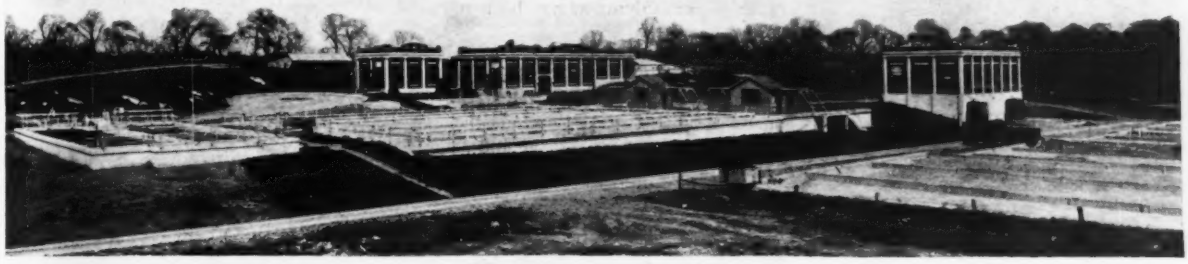


FIG. 1—THE NEW sludge filter building of the Hagerstown sewage-treatment plant and the original sludge-drying beds are at the right. The new office and laboratory and the original service building are in the center background.

Screens

From the 54-in. sewer the sewage passes first through bars spaced 2½ in. apart, cleaned by hand, and then through a cylindrical screen, 5 ft. in diameter and 4 ft. long, with ⅜-in. openings, located in the service building. The fine screenings accumulate in a pit or sump at the screen and are removed once each day by pumping to a 10,000-gal. sludge tank located in a wing of the building, where they are treated with lime and mixed with sludges also pumped to this tank. This portion of the treatment has been retained practically as originally installed.

Grease-separating tanks

From the fine screen the sewage passes through concrete conduits under the floor of the building to a grease-separating tank, a section of which is

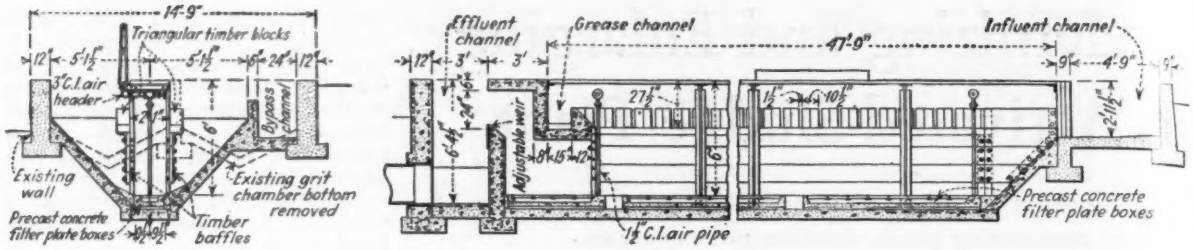


FIG. 2 — GREASE-SEPARATING TANK, cross-section and longitudinal section. Diffused air is used to float emulsified particles of grease to the surface. The grease floats through the notches in the baffles into the side channels of relative quiescence.

shown in Fig. 2. The tank is about 50 ft. long, 10 ft. wide and 4 ft. deep, and was constructed by modifying and partly reconstructing the original grit chamber. The grit chamber was considered no longer necessary because very little grit is found in the sewage, and the new plan provided preliminary tanks to retain the coarser solids.

The grease-separating tank is divided into three compartments by two longitudinal baffles. They are supported by steel framework and extend to within 6 in. of the bottom. Notched wooden timbers extend longitudinally on the top of the baffles, with the bottom of the V-shaped notches slightly below the water level. An adjustable weir at the outlet end holds the sewage in the tank at the desired elevation. A bypass channel is also provided. Air is introduced through a single row of diffuser plates at the bottom of the central compartment of the tank and mixes with the sewage. Oil, grease and scum brought to the surface by the air are forced laterally through the notches in the baffles into the side compartments, from which they are removed by hand into a collecting trough at the outlet end of the tank, thence into cans. All skimmings are transferred by hand to a small steel decantation tank, to secure better separation of grease. The floating grease is removed and buried or burned, and the subnatant liquid is returned to the preliminary tanks. A small dose of copper sulfate is added to the skimmings to prevent putrefactive odors.

About 50 per cent of the total amount of grease removed is collected in this tank, and the remainder is removed in the preliminary tanks, which are provided with grease skimmers. It is found that the amount of grease that may be removed from the preliminary tanks is much greater when compressed air is applied previously in the grease-separating tanks. The total amount of grease and scum removed varies greatly. It averages from 2 to 5 cu.ft. per day, although on some days as much as 15 to 20 cu.ft. is removed. Wastes from dry-cleaning establishments have been conspicuously in evidence at times.

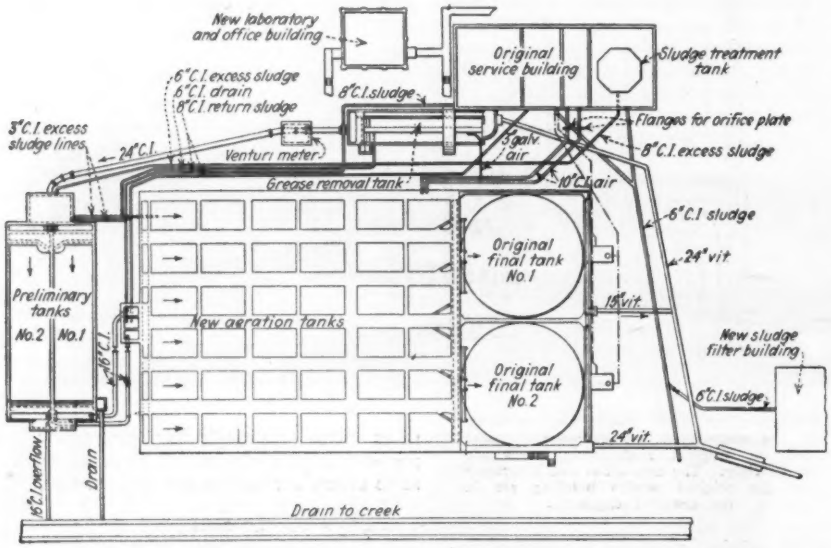


FIG. 3—SEWAGE-PLANT EXTENSIONS at Hagerstown, Md. The original installation included two mechanical aeration tanks. These tanks have been utilized as part of the new diffused-air aeration tanks. The grease-removal tank was constructed out of the old grit chamber. The preliminary tanks and the provisions for sludge dewatering are entirely new.

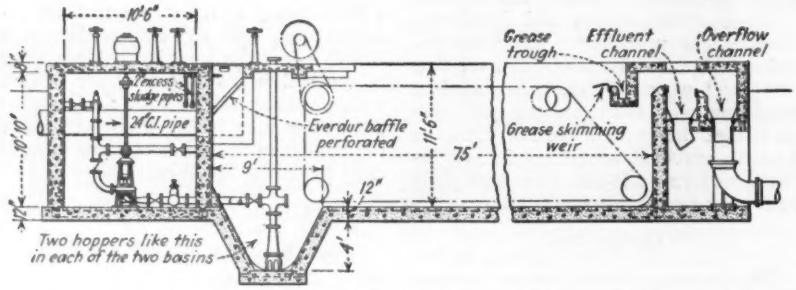


FIG. 4—PRELIMINARY TANK, longitudinal section. There are two such tanks, each 16 ft. wide.

Preliminary tanks

From the grease tanks the sewage passes through a new 24-in. cast-iron main, in which there is a venturi meter with register and recorder located in the service building, to two new preliminary settling tanks. These tanks are each 75 ft. long, 16 ft. wide and 10 ft. deep and are arranged in parallel so that either or both may be used. The sewage enters from behind perforated baffleplates made of corrosion-resisting metal, which distribute it evenly across the tank. The excess activated sludge, bled from the return-sludge mains, also enters the tanks with the sewage from behind these baffles.

The tanks are provided with sludge-removal mechanisms of the longitudinal-scraper type, which move the settled primary and activated sludge to sumps at the inlet end, and the surface scum and grease to the outlet end of the tanks. Sludge is pumped from the sumps by 3-in. vertical non-clogging centrifugal pumps, located in chambers adjacent to the sumps, to the existing sludge tank in the service building. Grease is removed at intervals by hand-

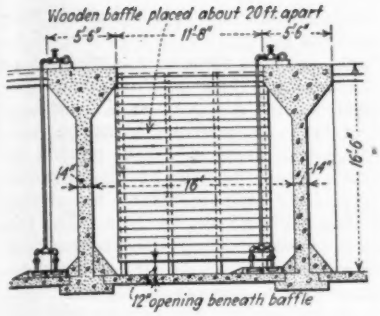


FIG. 5—AERATION TANK, typical cross-section. The wood baffles prevent short-circuiting through the tank.

skimming into a trough, which discharges into cans kept in a covered chamber at the side of the tanks. Skimmings are disposed of in the same manner as are those from the grease-separating tank. The settled sewage passes over weirs extending across the entire width of the tanks. Flows in excess of 6 m.g.d. are diverted over a weir to a drain leading to the creek.

Aeration tanks

There are six spiral-flow aeration tanks in two batteries of three tanks each. The sewage may be passed through either or both batteries, with the three tanks used in series or in parallel; or it may be passed through any one or more of the six tanks in parallel. The entire plant, in fact, may be operated in two independent batteries as to preliminary tanks, aeration tanks, final tanks and return-sludge pumps.

The tanks were constructed by extending the two original tanks, which were each 40 by 50 ft. in plan, a distance of 85 ft. One of the outside walls of the old tanks was cut down below the water surface and now serves as a baffle wall. Four transverse wooden baffles were installed in each aeration unit, extending from above the water surface to within 1 ft. of the bottom, to stop any tendency toward short-circuiting in the tanks.

Each of the six aeration units is 129 ft. long, 16 ft. wide and 15 ft. deep and is provided at the bottom along one side with a double row of air-diffuser plates, having an area of 188 sq.ft., or about 10 per cent of the tank area. Plates are also provided in the influent channel to prevent settlement of sludge.

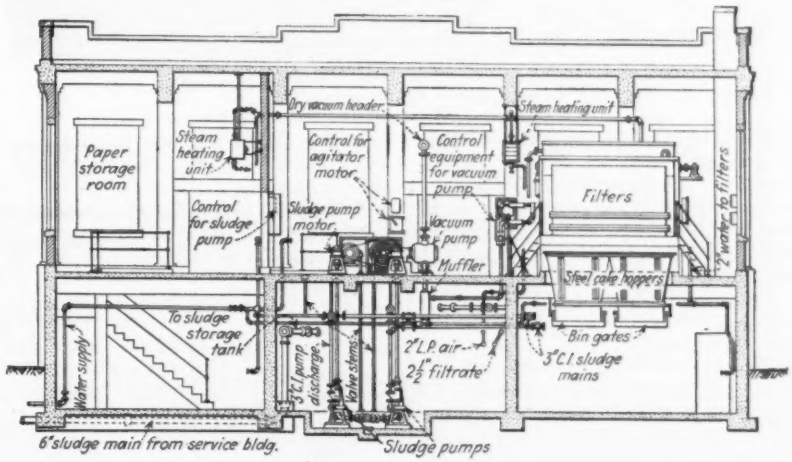
The sewage first enters an influent chamber into which is discharged also the return sludge taken directly from the final settling tanks by centrifugal pumps located in the service building. The rate of sludge pumping is regulated in accordance with the head upon orifices at the tank end of the sludge mains. Indications of this head are transferred to recording gages in the service building through small brass tubes kept full of air. The effluent from the aeration tanks passes out over weirs and through gated openings into the effluent channel. The arrangement of air piping, air plates and baffles is shown in Fig. 5.

Final settling tanks

The aerated liquor may be diverted, by means of gates in the effluent channel of the aeration tanks, to either or both of the two final settling tanks, which are about 50 ft. square and 10 ft. deep. These are the original final tanks, modified by the addition of a new inlet-distributing channel in each. The new channel comprises a wooden baffle, set into the tank 18 in. from the wall, extending to within 2 ft. of the bottom. Within the space between this baffle and the concrete wall there is a horizontal wooden baffle, placed 2 ft. below the sewage surface and having 2-in.-diameter holes spaced about 6 in. c. to c.

New sludge scrapers of the spiral type have also been installed in the tanks, and the corners have been filled in to steep slopes. The sludge is dragged to a center hopper and pumped continuously to the inlet chamber of the aeration tanks. Excess sludge is diverted to the inlet of the preliminary tanks through a branch from the sludge-return lines. A weir extends across the full length of each tank on the side opposite the inlet. Over this the clarified effluent passes in a thin sheet into a channel connecting to a covered drain leading to the creek.

FIG. 6—SLUDGE DEWATERING is accomplished by two vacuum filters. In the basement of the building housing the filter equipment and appurtenances are two concrete storage tanks (not shown in this section), one for sludge and one for pulped paper. Both are equipped with motor-driven paddlewheel agitators. Lime and ferric chloride are added to the sludge prior to filtration. The use of paper pulp has been discontinued.



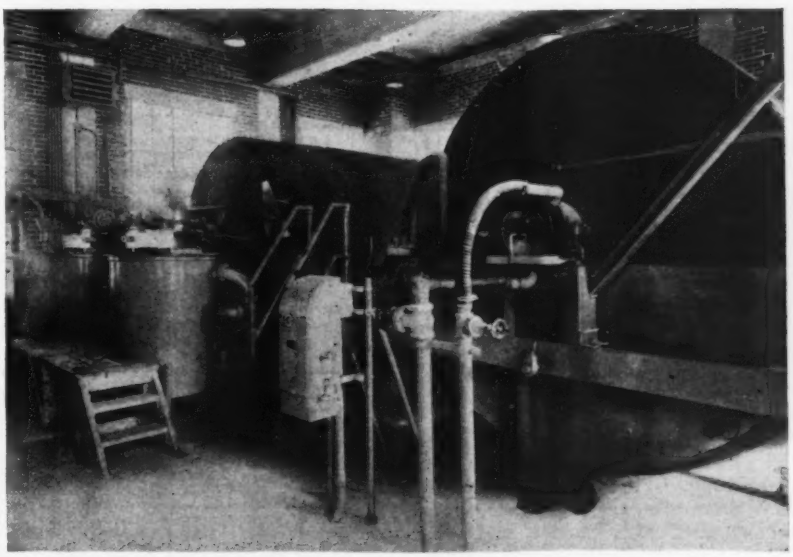


FIG. 7—SLUDGE FILTERS at the Hagerstown plant. The steel mixing tanks for the lime and ferric chloride are shown at the left.

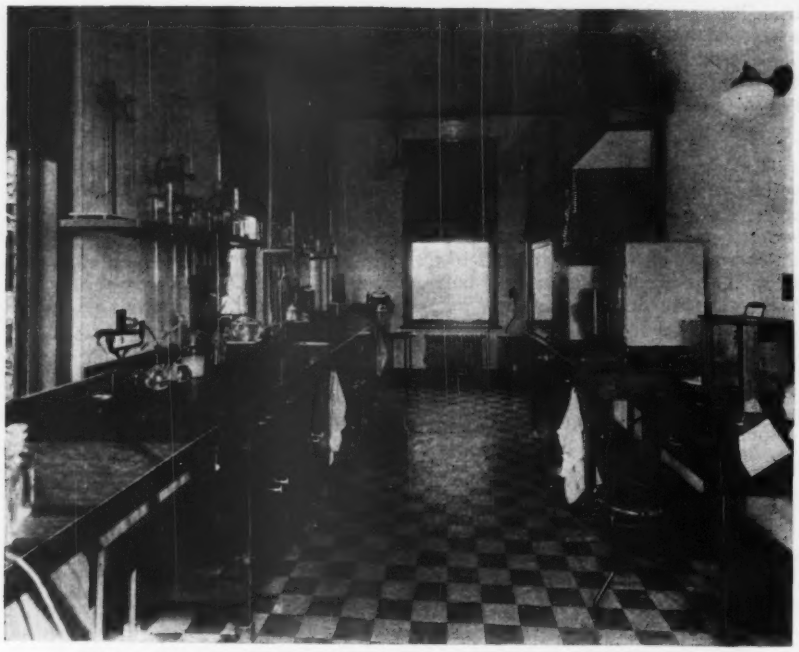


FIG. 8—NEW LABORATORY at the Hagerstown sewage-treatment plant is equipped to make all routine tests.

Air is supplied to the diffuser plates in the aeration tanks and the grease-separating tank by two electrically operated, three-stage, horizontal, centrifugal blowers. They are connected through speed-increasing gears to 75-hp., 2,300-volt, squirrel-cage induction motors.

Each blower has a nominal rated capacity of 1,500 cu.ft. of free air per min., at 60 deg. F. and 8 lb. per sq.in. discharge pressure. A range of discharge pressures from 7 to 9 lb. is provided to take care of variations in free-air temperatures and any increase in friction loss through the diffuser plates. The blower capacity is regulated by individual butterfly throttle valves in the suction pipes. Air is taken in through a suction duct with inlet above the roof and is filtered through three filter units, each with a rated capacity of 1,750 cu.ft. per min. Provision has been made for installation of a third blower unit when needed.

The operator is supplied with adequate information by two recording air-flow meters, two discharge-pressure gages of mercury manometer type and an air-filter differential gage. The air is discharged through two 10-in. headers provided with automatic check valves and through 10-in. cast-iron mains to the tanks.

Sludge-treatment facilities

The mixture of undigested screenings, primary and activated sludge, after conditioning, is dewatered by vacuum filters to an alkaline sludge cake which is inodorous, easily handled and suitable for use on the city-owned farm. Local conditions determined the selection of the sludge-filtering method. Before making the selection the following three methods of disposal were carefully considered.

1. Disposal by mixing the sludge and screenings with lime and drying it on sludge beds, the method used in the original plant. This method would have required extensive reconstruction of the beds, including removal and cleaning of the crushed stone and installation of underdrains. Also, it would have been necessary to provide extensive new sludge-bed area, a large portion of which would have to be glass-inclosed to provide suitable means for drying during cold and wet weather. The fact that the topography of the land available for this purpose would have required expensive rock excavation, together with the unsatisfactory experiences with this method in the past, led to the rejection of this plan.

2. Digestion of the sludge in heated digestion tanks and dewatering the digested sludge on sand beds. Inasmuch as extensive rock excavation would be required in construction of the digesters and also in necessary additional sludge-bed area, the capital cost of this method was considerably higher than the other two. There were also some uncertainties as to freedom from trouble in digesting the activated sludge and the effect of returned supernatant liquor ahead of the activated-sludge process.

3. Dewatering the undigested sludge on vacuum filters. The principal objection to this method was the necessity for obtaining a cake with high enough alkalinity to provide against odors of decomposition. There was little precedent for the production of such a cake from mixtures of undigested sludges.

TABLE I—ESTIMATED YEARLY OPERATING COST

	Total Yearly Cost	Cost Per Million Gallons
Labor and superintendence	$11,800	$12.90
Power and lights	12,000	13.11
Chemicals for sludge conditioning	4,000	4.40
Supplies for maintenance and repairs	1,400	1.53
Oil for heating buildings	700	.76
City water	600	.66
Miscellaneous, including gas, oil for trucks, laboratory supplies, telephone, insurance, etc	1,500	1.64
Total	$32,000	$35.00

TABLE II—GENERAL OPERATING DATA FOR MARCH, 1934

	Total	Daily Average
Connected population	.....	28,000
Sewage treated, m.g.	75.52	2.44
Total power, kw.-hr.	72,600	2,340
Power for sludge-filter operations, kw.-hr.	3,186	103
Compressed air for aerating sewage, cu.ft. per gal.	.....	.75
Return sludge, per cent of sewage flow	.....	36.5
Wet coarse screenings, cu.ft.	177	5.7
Wet fine screenings (3% solids), cu.ft.	3,170	102.0
Grease skimmings, cu.ft.	95	3.3
Suspended solids in aeration tanks, p.p.m.	.....	1,950
Suspended solids in return sludge, p.p.m.	.....	6,500
Sludge in aeration tanks, per cent (30-min. settling test)	.....	25
Sludge index (in aeration tank)*	.....	80
Suspended solids in screened sewage, p.p.m.	.....	187
Suspended solids in effluent, p.p.m.	.....	12
Per cent removal, suspended solids (exclusive of screenings)	.....	94
B.O.D. (5-day) in screened sewage, p.p.m.	.....	187
B.O.D. (5-day) in effluent, p.p.m.	.....	24
B.O.D. removal in per cent (exclusive of screenings)	.....	87
Dissolved oxygen in final settling tanks, p.p.m.	.....	4.6

$$\text{*Sludge index} = \frac{\%\text{ suspended solids in aerating tanks by weight} \times 100}{\%\text{ sludge volume in aeration tanks, settled 30 min.}}$$

TABLE III—SLUDGE-FILTERING DATA FOR MARCH, 1934

Sludge filtered, cu.ft.	65,700
Sludge filtered, dry sewage solids, lb.	121,570
Average solids in sludge filtered, per cent	3.0
Average filter yield, lb. per sq.ft. per hour	2.2
Lime (CaO basis), per cent of dry sewage solids	11.0
Ferric chloride (anhydrous basis), per cent of dry sewage solids	5.5
Average dry solids in filter cake, per cent	20.0
Power for filtering operations, per ton of dry sewage solids, kw.-hr.	53.0

However, a test-filter installation operated at Hagerstown in January and February, 1932, indicated that a yield of about 1 lb. of dry sewage solids per square foot of filter area per hour could be expected with the mixture of activated and primary sludges conditioned with lime and paper pulp, and that the sludge cake would not be odorous even though exposed for a number of weeks. Although at the time the tests were made very little activated sludge of good quality was obtainable from the mechanical aeration process then being used, the results were sufficiently satisfactory to justify a plant-scale installation.

The total cost of the new sludge-filtering facilities was about $50,000. Of this sum $16,000 represents the cost of the building, which is a two-story brick and concrete structure 62 ft. long and 34 ft. wide. The basement contains two sludge storage tanks, sludge filtrate pumps, heating equipment for all the buildings, space for receiving the filter cake directly into a truck from an overhead hopper and heated garage space. On the main floor are the two vacuum filter units, vacuum pumps, paper shredder, storage room and motors for the vertical shaft pumps and sludge-tank mixers.

Since the original installation, apparatus has been provided for iron-and-lime treatment immediately ahead of filtration, comprising a feeder for iron salt solution and a lime dry-feed machine mounted on a platform sufficiently large for lime and iron storage, steel mixing tanks placed adjacent to the filters for mixing each solution with sludge, and connecting piping.

The filters are equipped with string take-off filter drums, 8 ft. 6 in. in diameter by 10 ft. long, which have a net filter area of 260 sq.ft. each. The auxiliary equipment includes centrifugal sludge pumps of 3 and 5 hp., two 15-hp. vacuum pumps, one 20-hp. paper shredder, two 3-hp. filtrate pumps, sludge-tank mixers and chemical mixers.

Two methods of conditioning the sludge mixture before filtration have been used since the plant has been in operation: conditioning with lime and paper pulp, and with ferric chloride followed by lime. The first method was discontinued in favor of the second in January of this year because the yields were not uniformly as high as expected or required, the price of waste paper at Hagerstown became double the original price, and trials showed the second method to be more satisfactory.

Office and laboratory building

An office and laboratory building about 24 ft. square was provided in the new construction program. The building is a single-story brick and concrete structure fitted up in a thoroughly modern manner.

The laboratory furniture is entirely fireproof with metal cabinets and alberene stone table tops. Full equipment is provided for making all routine tests required. The laboratory tests are in charge of a full-time chemist under direction of the plant superintendent.

Construction cost

The total construction cost of the plant, including the original construction in 1924-26, additions and changes between 1926 and 1931 and the final program constructed in 1932 and 1933 was about $320,000. This is equivalent to $80,000 per m.g. of capacity, or $8 per capita. The above figure does not include the cost of land but does include engineering, supervision of construction and all other cost including that of the equipment and structures not now in use.

The total may be roughly subdivided as follows:

Original construction 1924-25-26, including screens, grit chamber, aeration tanks, clarifiers, service building, stormwater drain, sludge beds, piping and similar items	$142,000
Additions, 1926 to 1931, inclusive, including heating plant, new pump, screen plates and drive, changes and improvements in final tanks and removal mechanism, new sludge line, landscaping and miscellaneous items	13,000
1932-1933 construction program, including work done by city and by contract comprising grease-separating tank, two preliminary tanks, aeration tanks, sludge filter building and equipment, compressors, pumps, piping and miscellaneous appurtenances	165,000
Total cost	$320,000

During the first ten months the monthly operating cost has averaged approximately $2,600. This is equivalent to about $1.15 per capita per year and $35 per m.g. of sewage. Under present operating methods, sludge-filtering costs $12 to $14 per ton of dry sewage solids which equals $9.50 to $11 per m.g. of sewage treated. Table I shows the subdivision of estimated yearly operating cost, based on present costs.

Operating data for the full operating period are not shown because of lack of uniformity of operating conditions incident to breaking in a new plant and changing of sludge-filtering methods. In Table II, p. 736, operating data and results for March, 1934, are given. They are fairly representative of present operation. Table III is a summary of sludge-filtering data, also for March, 1934.

The analyses are based on samples collected at regular three-hour intervals throughout the day and night. Equal portions of these samples are composited and kept in an electric refrigerator at 40 deg. F. until the end of the day.

Personnel

The contract for the new construction was carried out by the J. B. Ferguson Co. of Hagerstown. Excavation, grading and changes necessary in existing structures were done by city forces under direction of H. E. Rhodes, who also is in charge of operation of the plant under Samuel Greenawalt, city engineer. The improvements were designed by Fuller & McClintock, consulting engineers, New York City, with the writer in direct charge, and construction and initial operation were supervised by the same firm. Kenneth K. King was resident engineer, and Wellington Donaldson supervised operation.

Spalling of Marble on Washington Monument

STUDIES are under way to determine a method of preventing spalling which has occurred on the marble facing of the Washington Monument. This spalling has been going on for several years and has reached such a stage as to mar the appearance of the lower portion of the obelisk. It occurs mainly on the lower 150 ft. of the structure and affects the marble mainly along the horizontal mortar joints. A possible explanation, according to the Bureau of Standards, is that the marble is supporting more than its share of the superimposed weight. With uniform distribution of the load over a horizontal section of the masonry at the ground level and maximum wind pressure, no part would be stressed as much as 700 lb. per sq.in.

Tests that were recently made on blocks of the same material that had been exposed to the weather for about 70 years indicated a bearing power of more than 5,000 lb. per sq.in., so that the spalling and cracking of the marble indicate that it is actually stressed much more than the theoretical 700 lb.

Details of the early construction of the monument are not available, but it is believed that a rubble masonry filling exists between the outside marble ashlar and the inside walls of granite ashlar. Thin mortar joints in the ashlar masonry and thicker mortar joints in the rubble fill would account for uneven distribution of the loading.

The studies now in progress are for the purpose of determining if a proposed plan of widening the horizontal marble joints for an inch or more from the surface and refilling with a more elastic mortar will overcome the spalling. For this purpose it was considered desirable to use marble of the same kind as that in the monument that had been exposed to the weather for a similar period of time. Some blocks were taken from the top of the old Patent Office Building for the experiments, since the marble in it came nearest to satisfying these conditions.

STABILIZED SOIL-BOUND ROAD SURFACES

II—Traffic Tests of Trial Roads

Behavior, under counted truck traffic, of test roads of various soil mixtures subjected to artificial rain storms and warm drying winds

By W. R. Collings and L. C. Stewart
Road Stabilization Department, The Dow Chemical Company, Midland, Mich.

EXPERIENCE in the stabilization of road surfaces plainly indicated the need of a study of soil characteristics and control in proportioning to obtain the best results. The preceding article in this series (*ENR*, May 24, 1934, p. 660) described the characteristics of soils and the laboratory test methods used. As no data were available on the relation between soil characteristics and service properties, The Dow Chemical Company extended its laboratory tests to actual service tests of various combinations of soils in standard test road sections. A careful study was made of the relationship between soil test values, gravel characteristics and the behavior of gravel-road mixes subjected to traffic. This article describes the road tests and gives the conclusions resulting therefrom.

A brick warehouse, 120x240 ft. and with an earth floor, was utilized for the road test. In it was built an oval track with straight sections 120 ft. long and 12 ft. wide on each side and banked curves of 40-ft. radius on the ends. Concrete curbs were built along each side of the straightaways, and boiler-plate fences around the banked-end section were provided to keep the test trucks on the road. Roads and testing equipment are indicated by Figs. 1 and 2.

At first, each of the straight sections was divided into four 30-ft. test lengths, the curved ends being used only for continuous operation of the trucks. After the first series of tests, however, the individual sections were reduced to 25-ft. lengths to provide a 10-ft. straight section at the end of each curve, as the side thrust of the cars coming off the curves subjected the end section to a type of wear different from that given the remainder of the straightaway. No joints or cutoffs were used between test sections.

Test results were desired on both wet and dry roads. To simulate rain for the wet-road test, an oscillating sprinkling system was installed along the inside curb of each straightaway. The sprinkling system consisted of a 2½-in. header pipe carrying spray nozzles at 6-in. intervals. In operation the sprinkling system threw a continuous spray of water back and forth across the road at a rate corresponding to 1.2 in. of rainfall per hour (Fig. 2). To dry the road after a wet test, a large portable steam heater and blower were installed and connected to air ducts leading along the outside curbs. Warm air blown through the ducts and across the road proved very effective in drying the road surface rapidly.

The straight sections were graded on a slope toward the inner curb where the runoff water was drained out through a tile drain. Portable splashboards set along the curb during wet tests returned all water splashed out by the trucks back to the road surface.

Inside the oval formed by the test road were built material storage bins and two mixing floors, 20x120 ft. Materials for the test were stored in eleven bins, each 20 ft. square.

The base course of the entire road was built from a sand-clay mixture that had been prepared in a near-by clay pit during the previous summer and fall months. In making this mixture a 6-in. layer of local bank sand was distributed over the clay base, and the two materials were mixed so as to incorporate about 2 in. of clay with the sand. After the

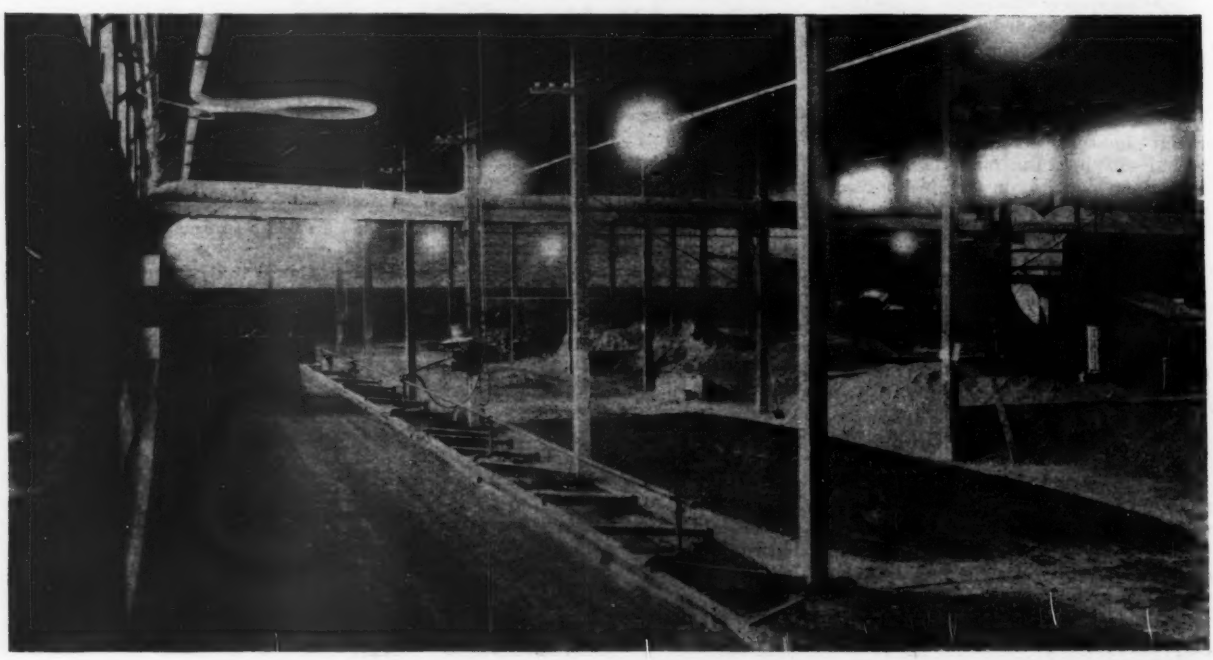


FIG. 1—DRY TEST in progress, showing surface condition and, at right, materials bins and mixing floor.

FIG. 2—WET TEST, showing at right perforated pipe for producing rain and at left warm-air duct for producing a drying wind.

sand-clay mixture was delivered to the test road, it was plowed, dried, disked and dragged to remove all lumps and thoroughly mix the material. The mixture was moistened and then compacted with trucks weighing from 4 to 10 tons. The curves were superelevated to an angle of 30 deg., using about 12 in. of the sand-clay mixture over a bank-sand fill. A stabilized sand-clay gravel was placed on the surface of the curves.

Preparation of mixtures

The test road mixtures were prepared by combining various proportions of natural silts, clays and coarse and fine aggregates. Fine aggregates were a standard sand mixture of one part of local bank sand and two parts of coarse sand from the outside. The sands were spread on the mixing floor and mixed by a horse-drawn spring-tooth harrow. After the sands were thoroughly mixed, they were spread in a hollowed-out low pile, and the silt and clay binder were added in the center. The binder materials were in a powdered or finely granular condition, prepared by crushing on the floor with a large steel roller. The clay was then slaked by adding water and stirring. The sand mixture was shoveled onto the slaked clay, and the entire combination of materials was thoroughly wet-mixed by the spring-tooth harrow. The desired coarse aggregate was then added to this mixture, which was again wet-mixed (Fig. 3). When laboratory tests indicated that the materials were uniformly mixed and possessed the desired test properties, the mix was set aside in a pile for use on the test road.

The finished mixtures were trucked to the test road and spread on the test section. A surplus of material was placed in each section to permit the surface to be cut down to the desired grade and crown with a small motor grader. To aid in compacting the wearing course, the loose surfaces were sprinkled once or twice each day to keep the materials damp until all test mixtures were in place. Then compaction of the test sections was obtained by light-weight trucks followed by heavier trucks. Light applications of water kept the material damp. When no further consolidation was obtainable, the test road was scraped with the motor grader. Standard practice was to provide a 3-in. slope from the outside to the inside of the track.

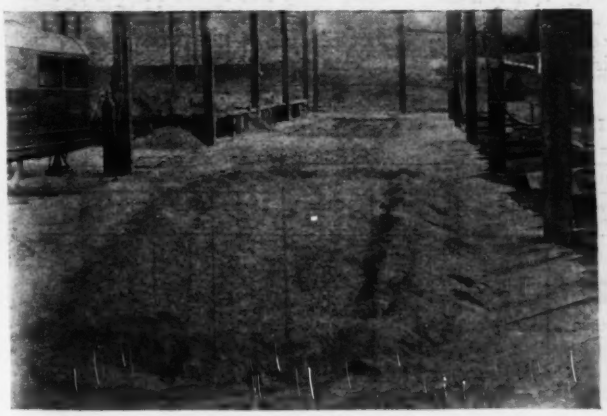
FIG. 3—MIXING METHODS for producing soil mixtures for tests of stabilized road surfaces.

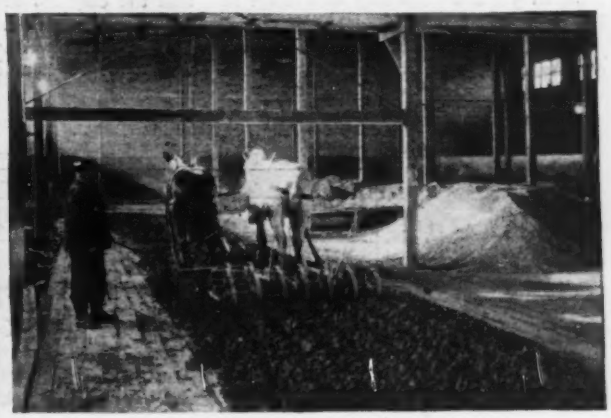
Test methods

The road sections were tested by operating two loaded trucks over the same lane of traffic throughout the entire duration of the experiment. The trucks weighed 7,800 lb. each and were equipped with 5-in. front tires carrying 60 lb. of air and 6-in. rear tires carrying 100 lb. of air. In the dry tests the trucks ran at an average speed of 20 miles an hour, while in the wet test, during which the sprinkling system was in continuous operation, the average speed was 18 miles an hour. Each of the wheel tracks made by the repeated trips of the trucks was about 20 in. wide.

The stability of the road mixes under traffic, in both wet and dry condition, was determined by the depth of wear or rutting in the lanes followed by the truck wheels. Before and after the various tests, measurements were made of the distance between the road surface and a straight-edge placed across the two curbs at right angles to the road. The difference between readings made before and after the test indicated the depth of wear or the amount of rutting. Readings were taken at each 0.4 ft. across the tracks at intervals of 1 ft. lengthwise of the road. The depths of the greatest depression at each station on each track were averaged for each test section. The resulting figure was used as a value for expressing quantitatively the stability of the various gravel mixtures.

With the exception of the first series of tests, the compacted and dampened wearing-course mixtures were treated with calcium chloride at the rate of ½ lb. per sq.yd., the equivalent of 2½ tons per mile applied over a width of 16 ft. A total of 5,000 trips by the trucks was then made on the road after the calcium chloride had dissolved and pene-





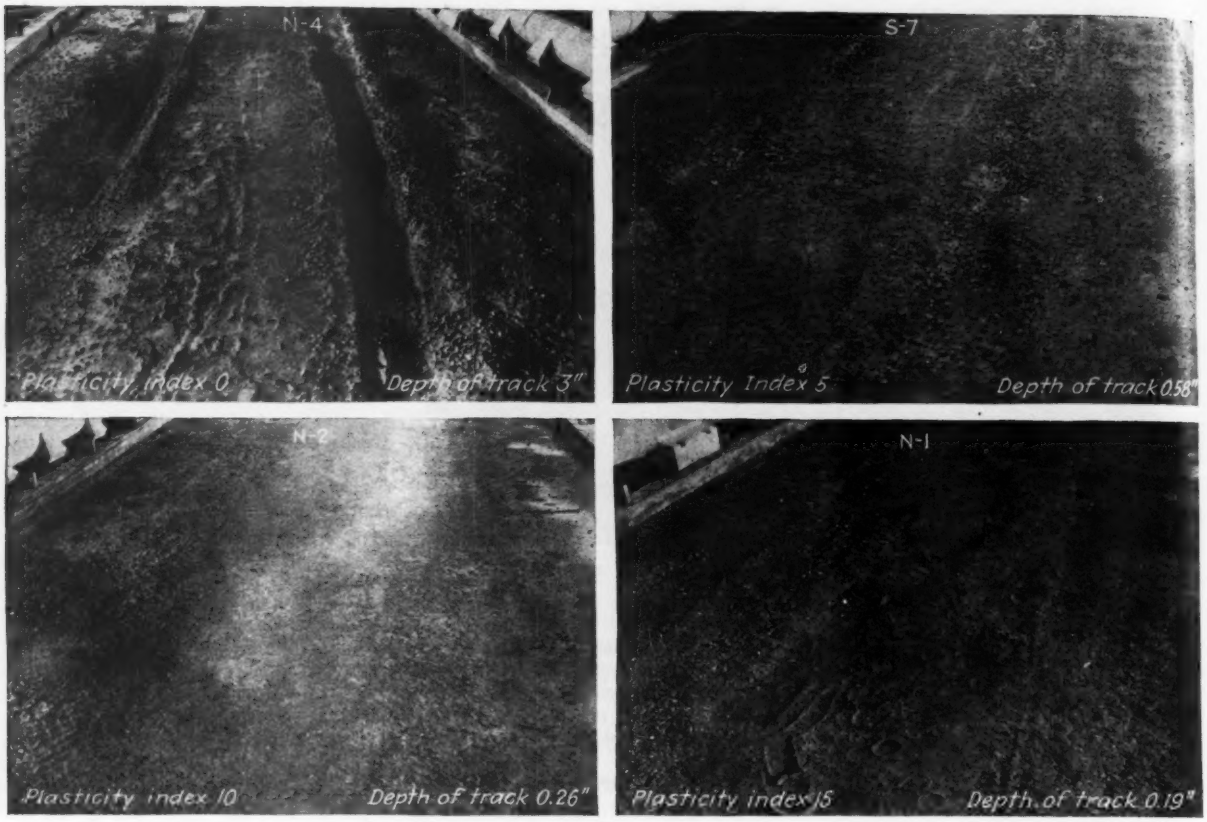


FIG. 4—Plasticity-index influence on soil mixtures subjected to 300 truck trips in the rain.

trated the wearing course. During the test the trucks changed direction of operation after each 100 laps.

In making the standard wet test the trucks were operated for a total of 300 trips during a steady fall of artificial rain at the rate of 1.2 in. per hour. The wet test followed immediately after the dry test, without reshaping or other alteration of the test sections following the dry test. In some cases the test sections failed under 200 laps of the trucks on the wet test, but the trucks continued operating to one side of the original lanes on these sections to finish the remainder of the test on the other sections. In some of the later series of tests on particularly stable gravels, it was necessary to run 600 trips to get a satisfactory difference in behavior of the test mixes.

The mechanical analysis of the various materials used in the tests and the results of the physical soil tests for the silt and clay are shown in Table I. It will be noted that practically all of the coarse aggregate was retained on the No. 10 sieve, making possible the accurate control of the proportion of soil mortar in the various mixes. In many of the tests a standard gravel mixture was used consisting of equal weights of crushed pebbles, smooth pebbles and pea gravel, designated as mixed gravel in Table I. The mixed sand consisted of two parts of a coarse concrete sand and one part local bank sand. The silt and clay were local materials, the silt containing approximately one-third clay and the clay containing approximately one-eighth silt as found in the bank.

In the first series of tests an attempt was made to establish the relationship between the plasticity index of a gravel mixture and its service properties. Crushed pebbles were used as coarse material in each section of this series of tests. It was aimed to produce test mixtures of equal proportions of coarse aggregate (retained on the No. 10 sieve) and of soil mortar passing the No. 10 sieve). The major variable in the mixture used in the first series of tests was in the plasticity index, which varies from 0 to 15. The mechanical analysis and physical tests of the various mixtures used are given in Table II, which also gives the results of the traffic stability tests.

The second or minor variable in the first series of tests is the silt content of the mixtures. As shown in Table II, there were two mixes for the 0, 5 and 10 plasticity-index mixtures. In the first of each of the three pairs of such mixes, all of the silt was contained in

TABLE I — ANALYSES OF MATERIALS USED IN SURFACING MIXTURES ON TEST ROAD

	Mechanical Analysis, Per Cent by Weight								Soil Tests Per Cent Moisture			
	Gravel				Coarse Sand	Fine Sand						
	Pass 1 in. on ¾ in.	Pass ¾ in. on ½ in.	Pass ½ in. on 4	Pass 4 on 10	Pass 10 on 40	Pass 40 on 270	Silt	Clay	Liquid Limit	Plas. Index	Field Moist.	Shrink. Limit
Crushed pebbles	22	45	31	1	1	..	..	..	..	..	..	..
Smooth pebbles	11	21	65	2	1	..	..	..	..	..	..	..
Pea gravel	..	..	52	39	8	1	..	..	..	..	..	..
Mixed gravel[a]	11	22	49	14	4	..	..	..	..	..	..	..
Coarse sand	..	..	1	27	40	32	..	..	..	..	..	..
Bank sand	..	..	..	..	2	98	..	..	..	..	..	..
Mixed sand[b]	..	..	1	18	27	54	..	..	..	..	..	..
Silt	..	..	..	..	1	6	59	34	25	7	19	18
Clay	..	..	..	..	2	8	12	78	57	37	23	15

[a]Equal weights of crushed pebbles, smooth pebbles and pea gravel.
[b]Two weights of coarse sand to one weight of bank sand.

TABLE II — EFFECT OF PLASTICITY INDEX ON STABILITY OF VARIOUS SURFACING MIXTURES USED ON TEST ROADS

Test No.	Mechanical Analysis Per Cent by Weight						Soil Tests Per Cent Moisture				Traffic Stability Tests Observations and Inches of Wear			
	Gravel[a]		Coarse Sand, Pass 10 on 40	Fine Sand, Pass 40 on 270	Silt	Clay	Liquid Limit	Plas. Index	Field Moist.	Shrink. Limit	Dry Test		Wet Test	
	On ¼ in.	Pass ¼ in. on 10									No calcium chloride. 3,000 trips.	½ lb. per sq.yd. calcium chloride. 5,000 trips.	300 trips in rain	
													Average wear	Deepest point
4	31	24	11	28	2	4	..	0	13	15	Frequent patching after 200 trips.	Frequent patching after 2,000 trips.	3.0[b]	3.0
5	28	22	12	28	4	6	..	0	11	14	Raveling at 1,000 trips.	Slight raveling at 3,000 trips.	1.1	3.0
7	31	23	12	24	3	7	18	5	13	14	Slight raveling at 1,000 trips.	No wear.	0.6	2.6
6	31	23	10	25	4	7	17	5	11	14	Slight raveling.	No wear.	0.6	1.8
2	30	22	10	24	4	10	21	10	12	14	Slight raveling.	No wear.	0.3[c]	0.9[d]
3	29	20	8	23	7	13	22	11	13	11	Very slight raveling.	No wear.	0.3	1.0
1	29	21	9	21	5	15	27	14	15	14	Slight raveling at 1,000 trips.	No wear.	0.2[e]	0.6[f]

[a]Coarse material in all mixes consisted of crushed oversize gravel.
[b]Required patching after 100 trips and was replaced after 200 trips.
[c]Average of three tests—respectively 0.26, 0.22 and 0.30 in.
[d]Average of three tests—respectively 0.72, 0.72 and 1.20 in.
[e]Average of three tests—respectively 0.19 0.18 and 0.10 in.
[f]Average of three tests—respectively 0.90, 0.42 and 0.54 in.
No shrinkage cracks visible after compaction of Nos. 4, 5 and 7; minor shrinkage cracks in Nos. 2, 3 and 6; large shrinkage cracks in No. 1. Local silt was added in Nos. 3, 5 and 6

TABLE III — EFFECT OF ADDITIONS OF SILT TO TWO TYPES OF SMOOTH AGGREGATE

Test No.	Mechanical Analysis Per Cent by Weight							Soil Tests Per Cent Moisture				Traffic Stability Tests Observations and Inches of Wear		
	Gravel			Coarse Sand, Pass 10 on 40	Fine Sand, Pass 40 on 270	Silt	Clay	Liquid Limit	Plas. Index	Field Moist.	Shrink. Limit	Dry Test	Wet Test	
	Kind	On ½ in.	Pass ½ in. on 10									½ lb. per sq.yd. Calcium chloride. 5,000 trips	300 Trips in Rain	
													Average Wear	Deepest Point
15	Smooth	14	39	11	26	3	7	18	6	12	13	Slight raveling.	1.1	2.5
14	"	15	39	10	22	6	8	17	6	11	12	Slight raveling.	0.4	0.9
10	"	15	38	8	23	5	11	22	11	13	13	No wear.	0.3	2.0
11	"	13	34	8	22	10	13	22	11	13	12	No wear.	0.2[a]	1.2[b]
9	"	13	33	8	22	4	20	28	15	16	11	No wear.	0.2[c]	0.7[d]
21	Pea	0	48	12	25	4	11	20	10	15	11	Slight raveling.	0.9[e]	3.1
20	"	0	41	11	26	7	15	21	10	12	12	Slight raveling.	0.2	0.7
19	"	0	50	12	20	4	14	27	15	13	13	Slight raveling.	0.5[e]	3.2
22	"	0	47	10	15	10	18	27	15	16	12	Slight raveling.	0.2	1.3

[a]Average of two tests—respectively 0.22 and 0.18 in.
[b]Average of two tests—respectively 1.56 and 0.90 in.
[c]Average of two tests—respectively 0.12 and 0.20 in.
[d]Average of two tests—respectively 0.48 and 0.84 in.
[e]Traffic was operated only 200 trips on lanes which were measured, due to holes.
No shrinkage cracks visible after compaction of Nos. 14, 15 and 19; minor shrinkage cracks in Nos. 9, 11, 20, 21 and 22.
Local silt was added in Nos. 11, 14, 20 and 22.

the clay. In the second of each pair, a higher silt content was obtained by using a mixture of equal weights of the natural silt and clay to give the desired plasticity index to the entire mixture.

The first traffic test was conducted on the various gravels after they had been compacted in a damp condition with trucks and had been allowed to dry, but without the application of any calcium chloride. This test, consisting of 3,000 trips, is listed in Table II under the first dry-test column. After completion of the 3,000 trips, the road was reshaped and ½ lb. of calcium chloride per sq.yd. was applied. Following this, the second dry test of 5,000 trips was performed. Immediately following, 300 trips were run in the artificial rain.

It will be noted from Table II that as the plasticity index increased, the traffic stability values improved. It is also interesting to note the effect of increased silt content on the various mixtures. Benefit of silt was most apparent in the mixtures having lower plasticity indexes. It is also of interest to note how well the test results checked each other when repeat runs were made on the same mixes, as shown in the foot notes in Table II.

Although field moisture and shrinkage limit tests were made on all wearing courses, there does not appear to be a definite relationship between those values and the service properties of the gravels. In general, the higher plasticity-index (hereafter abbreviated as P.I.) mixtures developed more shrinkage cracks than those with the lower P.I., but as the dry traffic was continued on these mixtures after treatment with calcium chloride, the shrinkage cracks gradually sealed shut.

The effect of the use of calcium chloride on the various mixtures is also shown in Table II. For example, in test No. 4, before calcium chloride was applied on the zero P.I. gravel to which no extra silt was added, frequent patching was required after 200 trips of the trucks. After calcium chloride was applied to this section, patching was not required until 2,000 trips had been made. In the mixtures having the higher plasticity indexes, slight raveling was noticeable at the end of 3,000 trips without calcium chloride treatment, but no wear was visible at the end of 5,000 trips after the calcium chloride had been applied.

The conditions after the wet tests of four of the sections with 0, 5, 10 and 15 P.I. are shown in Fig. 4. The following conclusions may be drawn from results obtained in the first test series:

1. Wearing-course mixtures that have 50 per cent of soil mortar resist wet-weather traffic wear best when the plasticity index of the soil fines is from 10 to 15.

2. Some silt is of value in improving both wet and dry stability of similar mixtures, particularly if the P.I. is low.

3. Dry-weather raveling of gravel surfaces is greatly reduced by the presence of ½ lb. of calcium chloride per sq.yd.

4. A P.I. of 5 or more is required to secure the most satisfactory degree of resistance to raveling under dry conditions from the use of calcium chloride.

Second and third test series

Further tests on the effect of the plasticity index and of silt content on gravel stability were performed, using smooth pebbles as coarse aggregate for the second series and pea gravel for the third series. The mixtures and results of tests are given in Table III. All of these mixtures contained approximately equal amounts of coarse material and soil mortar except test mixture No. 20.

The test on the dry surfaces without calcium chloride treatment was discontinued, as it was obvious from results of the first series that moisture cohesion must be retained under dry con-

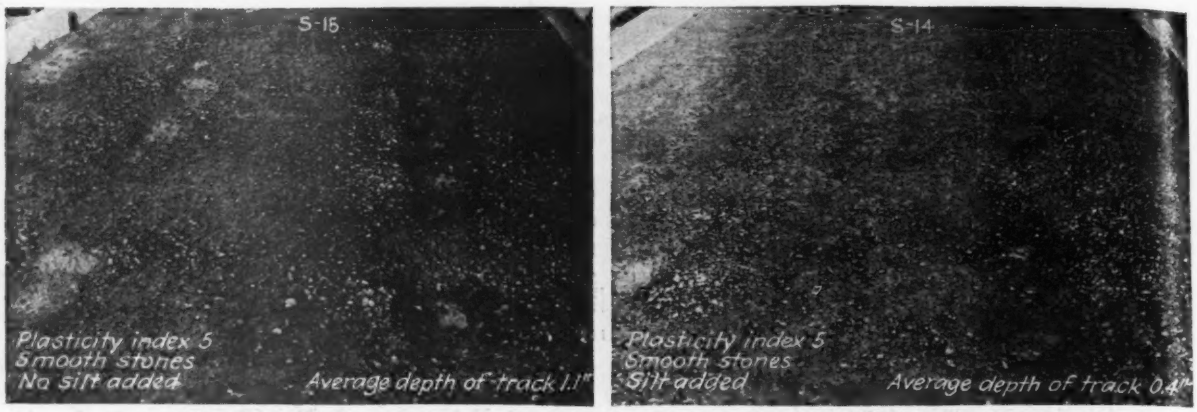


FIG. 5—SILT EFFECT on smooth stone mixtures after 300 truck trips in rain; without silt left, with silt right.

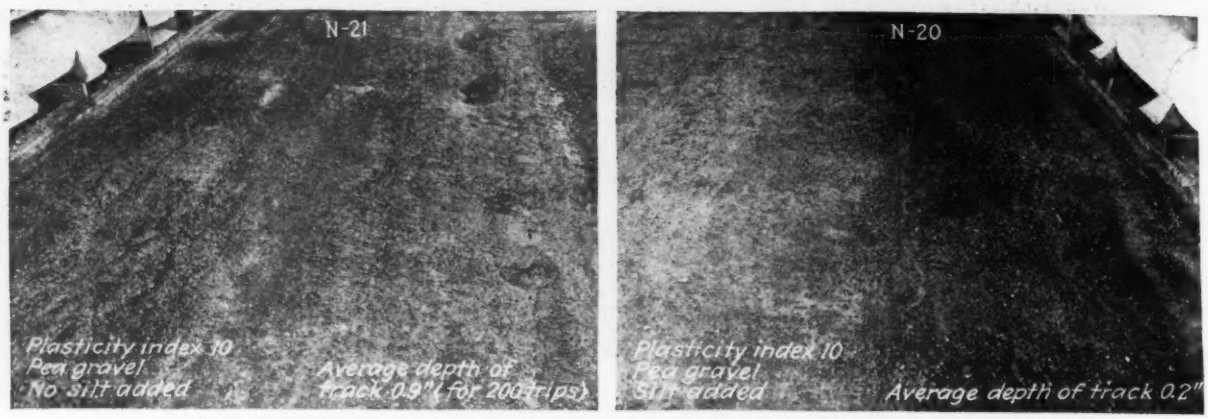


FIG. 6—SILT EFFECT on pea-gravel mixtures after 300 truck trips in rain; without silt left, with silt right.

ditions. Consequently, the surfaces were prepared and treated with calcium chloride and tested dry by 5,000 laps of the trucks, the results being listed in the dry-test column of Table III. Then, without regrading or altering the surface, the wet tests were made.

In the second series of tests the effect of increased plasticity index is again quite marked. As this cohesive value was increased from 6 through 11 to 15, the average wear for the wet test was materially reduced. The effect of extra silt added to test mixtures Nos. 14 and 11 is particularly noticeable in the comparison of those mixtures having the lower plasticity indexes, Nos. 14 and 15. Views of typical results of the second series of tests are shown in Fig. 5.

In the third series of tests pea gravel was used as the coarse aggregate. Two pairs of mixes were tested, the P.I. of the first pair being 10, and of the second pair 15. The second mix of each pair, Nos. 20 and 22, Table III, contained an extra quantity of local silt, while the first mix of each pair, Nos. 21 and 19, contained only the silt that was present in the natural clay binder. The effect of the plasticity index on reduction in wear under wet conditions was most evident in these latter mixes that contained no extra silt. The benefit of the silt was very marked in reducing the wet wear of the 10 P.I. mixes. The value of the silt was strikingly noticeable in the depth of the pits which occurred, with and without the addition of this very fine fractional material. Without the extra silt in both the 10 and 15 P.I. mixes, there was at least one pit that went entirely through the 3-in. layer of the wearing course. With the extra silt present in the 10 P.I. mixture, the deepest pit was only 0.7 in. Views

FIG. 7—SOIL-MORTAR quantity effect on mixtures having same plasticity index; results of tests on wet road.

TABLE IV — EFFECT OF PROPORTION OF SOIL MORTAR ON GRAVEL STABILITY

Test No.	Mechanical Analysis Per Cent by Weight: Gravel* On ¼ in.	Gravel* Pass ¼ in. on 10	Coarse Sand, Pass 10 on 40	Fine Sand, Pass 40 on 270	Silt	Clay	Soil Tests Per Cent Moisture: Liquid Limit	Plas. Index	Field Moist.	Shrink. Limit	Traffic Stability Tests Observations and Inches of Wear: Dry Test ½ lb. per sq.yd. Calcium chloride. 5,000 trips.	Wet Test 600 trips in rain: Average Wear	Deepest Point
25	19	42	11	14	5	9	20	10	14	12	Very slight raveling	0.4	1.8
	61												
24	15	36	9	21	8	11	21	10	13	11	Very slight raveling	0.2	0.3
	51												
23	9	26	12	27	10	16	21	10	11	11	No wear	0.2	0.4
	35												
27	21	46	5	11	6	11	28	15	15	11	Slight raveling	0.7	2.6
	67												
26	16	36	7	17	8	16	27	15	14	11	Slight raveling	0.7	0.3
	52												
28	9	25	8	22	13	23	27	15	15	10	No wear	0.2	0.4
	34												

*Coarse material was obtained by using a mixture of equal weights of crushed oversize pebbles, smooth pebbles and pea gravel.
Large shrinkage cracks were present after compaction of Nos. 23 and 28; minor shrinkage cracks in all other sections. Local silt was added in all mixes.

of the pea-gravel test are shown in Fig. 6.

In general, the second and third series tests corroborate the conclusions drawn from the first series in regard to the relation of plasticity index to stability. In addition, however, the following deductions may be made:

1. Stabilized sand-clay gravels in which the coarse aggregate consists of pea gravel under ¼ in. in size offer less resistance to rutting than similar mixtures containing about 15 per cent of material over ¼ in. in size. The pea-gravel aggregate may be compared to the smooth pebbles in Table III.

2. Silt is of more marked value in improving the stability of mixtures in which pea gravel is the aggregate than it is when larger aggregates are used.

Effect of soil mortar on stability

A fourth series of tests was made to compare the service properties of mixtures having the same plasticity index but containing different proportions of soil mortar to coarse material, the coarse aggregate listed in Table I as mixed gravel being used. In all cases local silt was added to the binder soils. Three proportions of coarse material, 35, 50 and 65 per cent, were selected to give a suitable range of variation. Two sets of such mixtures were compared. One set has a P.I. of 10 and included tests 25, 24 and 23, Table IV. The other had a P.I. of 15 and included tests 27, 26 and 28 in the same table.

The dry test was run after the application of calcium chloride, the same as in the second and third series. However, it was necessary to extend the wet tests in this series to include 600 trips of the trucks, as the wear at the end of 300 trips was not sufficient to give marked difference in the wearing properties of the mixtures.

As shown in Table IV, the wear in the dry test diminished somewhat as the percentage of coarse material or gravel decreased. In the wet test the improved resistance to wear with increased proportions of fine materials was more pronounced. In the first set of tests, in which the P.I. was 10, the average wear was reduced from 0.4 to 0.2 in., with a decrease in coarse material content from 61 to 51 per cent, and remained at 0.2 in. when the coarse material was decreased to 35 per cent. The same general relationship was obtained on the 15 P.I. mixes.

In both sets of tests the material having the highest gravel or aggregate content showed the greatest wear and the deepest pits, but there is little difference evident between the performance of the mixtures containing 35 and 40 per cent coarse material. Mixtures 23 and 25, having 35 and 65 per cent coarse material, respectively, and both having a P.I. of 10, are shown in Fig. 7 after the wet test.

From the fourth series of tests we conclude that quantities of coarse material in excess of 50 per cent of the total are of doubtful value in stabilized mixtures. Further study of this and other phases of stabilized wearing course behavior are being conducted, using the indoor test road. The results of these tests will be made public as soon as they are available.

In the next article the construction and maintenance of stabilized surfaces will be described.

Abandoned Coal Mines Sealed to Prevent Acid Seepage Into Streams

STREAM CONTAMINATION resulting from seepage containing sulphuric acid from abandoned coal mines in West Virginia has resulted in the sealing up of more than 1,200 during the past few months. The work was carried out as a CWA project. The mines sealed were located on the Cheat, West Vork, Tygart, Monongahela, Coal, Kanawha, Guyan and Tug rivers, according to a report by E. S. Tisdale, state department of health. There are at least 3,000 more abandoned coal mines in the state still to be sealed.

The first result of stream pollution that attracted the attention of engineers was the high mortality among fishes. However, other results such as corrosion of metal in locks and boats and the public health menace are of far-reaching importance. The water-purification problem is an important consideration. It was estimated that one abandoned coal mine in Marion County was discharging as much as 12,000 lb. of sulphuric acid solution into the Monongahela River every day.

Although the engineers of the U. S. Bureau of Mines estimate that from one to three years will be required for complete return to alkaline conditions of the waste-water drainage from these mines, tangible results are already apparent. At one of the mines in Boone County an analysis of the water indicated that three weeks after the mine had been sealed, the acid content of the seepage water had been reduced by 25 per cent. In another instance it was found that water from a sealed mine had already changed from an acid to an alkaline condition.

Following the posting of notices for removal of property and warnings against entering the mines, walls of concrete, brick or stone are built across the mouth of each mine drift. These seals contain a trap at the bottom, which excludes air and thus prevents chemical action or the oxidation of the sulphur compounds common to the coal veins of this region. The seals do not interfere with the mine drainage or prevent the outflow of seepage water.

Model Highway Safety Code and Signal Manual Drafted

National conference approves six uniform acts and standard signals—Uniform gross weights for vehicles voted down and authority to regulate weights given to states —Varicolored light signals excised from safety code

FIVE STATE ACTS and a municipal ordinance, with a manual of standard traffic signs and signals, were approved as models for highway safety legislation by the Conference on Street and Highway Safety held in Washington, D. C., on May 23-25. About 400 delegates assembled for the conference; they included state and city traffic officials, federal and state highway engineers, representatives of railways and motor-transport lines, independent consulting engineers and teachers, federal department heads and governors and other high state executives. Attendance at all of the six sessions was seldom less than three-fourths of the full registration, and each of the acts and other documents presented by the special committees was considered section by section and discussed, deleted, amended or approved by vote of the full conference. Redrafted as directed by vote, the full code of laws, which will be soon printed and available, represents the conclusions of the conference as represented by majority vote.

Active difference of opinion

The documents presented by the special committees were accepted in general with modifications in detail only. This was due largely to preconference hearings of these committees on May 21 and 22. At these hearings most of the minor changes had been presented and agreed upon, and with committee motion for adoption were rapidly handled when they came before the full conference. In three particulars the changes were more comprehensive and drastic. First, a complete reorganization of the draft of the municipal ordinance was adopted; second the optional section (No. 34) in the uniform traffic act (Act V), providing for "special color combinations in signals," was deleted; and, third, a substitute section was adopted, completely changing Section 177, Act V, specifying gross weights of vehicles and loads.

The changes in detail, numbering more than 100, were in general amendations, extensions or deletions altering parts of sections, and space does not permit enumeration. They will be contained in the revised code to be published soon. The major changes noted above are presented in order, with a summary of the reasons presented in the discussions that influence action.

As drafted, the uniform municipal traffic ordinance presented together provisions governing users of the streets and provisions specifying administrative procedure and practice, with an appendix citing the state law provisions that might be included at specified places in the ordinance as basic rules of the road having universal application.

In discussion, this arrangement was criticized as confusing administration with traffic rules, and separation was urged. This objection was recognized by the committee, which moved for conference vote that the ordinance be amended so as to be divided into three separate parts, the first part to be known as the Uniform Municipal Traffic Ordinance and to contain those provisions which apply to and govern the actions of the users of the streets and highways; the second part to contain those provisions which are purely administrative and shall be recommended for adoption by municipalities in such parts or part as is permissible under their charters, or financial ability to perform; the third part to contain provisions contained in the state code which may be repeated in a local ordinance. This action was approved by the conference and accomplished a change in organization without material change in wording and requirements except in respect to the powers and duties of traffic commissions (Sect. 125). This section was changed to create the position of traffic engineeer and an enforcement division of the police department, and to delete from the powers of the traffic commission that of conducting traffic surveys, studies and investigations.

Color combination signals

In a formal memorial to the committee on uniform traffic laws and ordinances, by Robert H. Nau, Chicago Association of Commerce, Leslie J. Sorenson, city traffic engineer of Chicago, and E. J. McIlraith, Chicago Surface Lines, and in discussion by them and others at the preconference committee hearings, protest was registered against Sect. 34, Act 5, the optional section providing for color-combination signals. The argument in general was:

This section allows vehicular traffic the right to move on green and yellow, or upon a green-alone indication. Here then is a case where the illumination of a normal yellow lens on a traffic signal has no bearing on the movement of vehicles, which is absolutely contrary to all present conception of color regulation. From the time the first traffic signal was placed in service the yellow light has had a distinct meaning as warning and has become thoroughly understood as such.

In this section the yellow coming on *with* the green is an indication for the pedestrian alone to follow. How easily will drivers and pedestrians learn to recognize that certain uses of yellow are only for the pedestrian? How will such optional use aid uniform practice and help safety? What could be the effect on the street users of trying to keep clear all these varieties of special uses and options? There has never been in the life of the traffic signal any legend to signify that the illumination of the green and yellow lenses apply to the pedestrian only and not to the motorist. The effect would be to throw into utter confusion all understanding as to what is meant and to kill respect for the light control and therefore greatly increase public hazard.

Red and yellow together is proposed to indicate an exclusive pedestrian period. If conditions warrant a period set aside for pedestrian travel, then such period should have an exclusive indication in the form of a "walk" signal. The idea that the colors red, yellow and green when used alone apply to motorists, and when used in combination apply to pedestrians, with confusing cross-applications, are far too complicated to be effective. If the pedestrian is to be protected, a better form than a mixture of vehicular indications can be found by which to do it.

In consideration of the objections, the committee brought to the conference a recommendation to delete optional Sect. 34, Act V, and it was adopted. In this connection action was taken by the committee on traffic-control devices to recommend to the conference a new Sect. 223½ to the manual, and this was adopted. In abbreviated form it was:

There is a growing demand for special pedestrian signals for two different purposes: (1) to provide a separate interval for pedestrian movement in all directions, all vehicular movement being stopped; and (2) in connection with the standard cycle, to tell the pedestrian when he may safely start to cross so as to complete the crossing before traffic starts on the other street.

The addition of a separate pedestrian interval slows up the entire cycle and is therefore justified only in exceptional cases where there are many vehicular turns combined with heavy pedestrian traffic or where vehicular movement is continuous, as in some traffic circles. Where required in such locations, it is recommended that red be shown in all directions to stop vehicular movement and that a special "walk" signal be provided for pedestrians.

Such pedestrian signals generally show the word "walk" illuminated on a dark background. The best practice requires that when this signal is dark a similar

"Wait" signal should be displayed to advise pedestrians not to cross. These may be carried on the same post as the vehicle signals or on a separate post, and in either case at a height of about 6 ft.

For the second purpose mentioned a special pedestrian "walk" signal is also recommended where justified by large traffic volume and high speed. Ordinarily this will first appear simultaneously with the appearance of the green vehicular signal in the same direction and will disappear a sufficient number of seconds before the disappearance of the green so pedestrians who start on the "walk" signal can clear the intersection before the green signal is given to vehicles in the other direction. In special cases the "walk" signal may be arranged to appear during any desired portion of the green interval. Such special signals are considered preferable for this purpose to the use of green and yellow in combination.

Gross vehicle weights

In the uniform traffic act (Act V, Sect. 177) the gross weight of vehicles, as given in *Engineering News-Record*, May 24, 1934, p. 669, met with active opposition both in the preconference committee hearing and afterwards in the conference deliberations. As a result of the hearings, the special subcommittee divided and presented a majority and a minority report, the majority report favoring retention of Sect. 177 as written. The general committee adopted the majority report of the subcommittee and presented the section as written for consideration of the full conference. The majority and the minority members of the committee each placed statements before the conference.

Discussion before the conference promising to be protracted, it was voted to limit discussion of appointed spokesmen to 40 min. for each side and to limit general discussion to not more than 5 min. for each speaker. Broadly the discussion was between representatives of the motor-vehicle transportation interests as proponents of the act as written and representatives of the railways as opponents, with a brief defense of the committee action by E. W. James, of the Bureau of Public Roads, and without active or significant offerings of opinion by representatives of other interests. The lines taken by the arguments were briefly as follows:

Supporting the Act—One of the principal subjects on which a greater measure of uniformity is most needed is that of the gross weights of vehicles. The laws of the several states have varied widely despite the standardization of motor vehicles of all types under American mass-production methods, and despite the uniform standard of excellence which the 200,000 miles of main rural and intercity highways are rapidly approaching.

Within the last five years three significant developments have occurred: Solid tires on heavy vehicles have been almost completely replaced by pneumatic tires, thus reducing drastically the effect of such vehicles on highway pavements. The balloon tires introduced even more recently, and now standard equipment in the manufacture of buses and trucks, have carried further this reduction in the destructive effect of heavy loads on the highways. Because of the rapid progress of the art of highway construction, there has resulted a high degree of standardization in highway practice throughout the nation.

Sect. 177a, as drafted, actually represents a curtailment of permissible gross loads in that it fixes maximum limits to the gross weight of vehicles dependent upon length, "which shall not be exceeded." It has been said in opposition that, "Adoption of Sect. 177a would change the fixed policy and practice in many states." The very existence of this National Conference on Street and Highway Safety is sufficient proof of the fact that the policies and practices heretofore in effect are often susceptible to improvement, which obviously entails changes in some state laws.

Opposing the Act—The gross weights recommended are considerably at variance with present practice in the great majority of states; some states have lower limits, while others have higher limits. The general adoption of the proposed weights would have the following effects: (*a*) 36,000 lb. on two axles would not change the existing gross weights in four states and would permit an increase in 44 states. (*b*) 49,000 lb. for any single vehicle of maximum length with more than two axles would decrease the present limit in only two states, would increase the existing limits in 45 states, and make no change in one state. In fourteen of these states the increase would be over 100 per cent. In ten states the increase would be over 140 per cent. (*c*) 49,000 lb. for a combination of truck-tractor and semi-trailer would decrease the present limits in nine states and would increase existing limits in 39 states. In thirteen of these states the increase would be over 50 per cent, and in nine states 145 per cent or greater. (*d*) 56,000 lb. for a truck and trailer would reduce the present limits in 26 states, and provide increases in 22 states.

Different state policies, different local conditions, differing types of highways and bridges, differing widths and gradients of roadways and differing volumes of traffic all dictate the conclusion that each state should decide, in the full knowledge of its local policies and conditions, the size and weight limits to be placed on commercial vehicles used on the public highways. There is some merit to the argument that uniform gross weights throughout the country would be advantageous, but it is quite evident that the *primary* interest has been to increase the size of motor vehicles, while uniformity has been a *secondary* concern. If uniformity has been a prime consideration, this end could have been achieved much more easily through the adoption of a considerably lower maximum weights.

Substitute section adopted

By vote of the conference a substitute section was ordered submitted to the conference drafting committe for consideration. This committee returned a new draft embodying substantially the terms of the substitute section which were that "in view of the varying conditions of traffic and lack of uniformity in highway construction in the several states, no uniform gross-weight limitations are recommended for general adoption throughout the country." "For the protection of bridges, the American Association of State Highway Officials recommends the following formula: $W = 700$ (L plus 40) where W = the gross weight in pounds and L equals the length in feet between centers of first and last axles of a vehicle or combination of vehicles."

It was provided that every such vehicle should meet the following requirements:

1. It shall be equipped with brakes as required in Sect. 151 of this Act.

2. Every motor vehicle to be operated outside of business and residence districts shall have motive power adequate to propel at a reasonable speed such vehicle and any load thereon or to be drawn thereby.

Iraq Pipe Line Completed in Near East

LAYING and welding of the 1,200-mile pipe line in the Near East, connecting the rich oil fields of Iraq with the ports of Tripoli in Syria and Haifa in Palestine, are reported completed. The line is notable because of its unusual length, because of the difficulties encountered in laying it across desert country populated by unfriendly tribes, and because it is jointly owned and operated by British, French, Dutch and American oil companies.

According to the Lincoln Electric Co., of Cleveland, whose welding machines and shielded arc electrodes were used, four welding crews, composed principally of Americans and a small number of British, French and native operators, constructed the line. These crews were assisted by about 300 native helpers. About 12,000 men were employed in all phases of construction. Geographical conditions and the elements presented the major difficulties encountered. Desert storms were particularly bad, and gas masks were used successfully as a protection from sand. During the winter months floods were common. Extreme variations in temperature were also troublesome. Actual laying of the line and all the welding were completed in thirteen months.

Letters to the Editor

Public-Works Expediency

Sir—Your May 10 issue reports that the United States Chamber of Commerce discussed the need of further public-works programs. I cannot help being impressed with the fact that a large public-works program is essential for recovery, but likewise that it has not been approached from the right angle. It seems to me that the greatest criticism that can be made against it, and in fact against many of the activities of the present administration, has been the fact that they have placed too much administrative authority in the hands of local agencies, so that expediency and political activities have control.

Harrison P. Eddy, president of the American Society of Civil Engineers, makes the statement that 4,700 nonfederal projects are now pending in Washington, calling for the expenditure of three billion dollars. Many of these projects are meritorious, and I do not doubt but that many others are no good. On the other hand, there are, without question, many meritorious projects which have not been submitted because they did not have sufficient political backing or because they required considerable expenditures for preparation of preliminary plans and estimates.

I cannot help but be impressed with the situation in California. Here we have the Central Valley Authority asking for $170,000,000, the Metropolitan Aqueduct asking for $60,000,000, the Water and Power Department asking for $27,000,000, a total of $257,000,000. These projects call for a three- to five-year construction program, work to be located in remote areas. They cannot begin to afford the relief for unemployment that could be obtained from projects in urban areas where unemployment need is greatest. Men with families working on these projects will be forced to maintain two establishments. However, these projects have the big drive behind them, and local projects situated where unemployment is greatest cannot get the support.

Los Angeles, Calif., May 15, 1934. DONALD M. BAKER.

Elementary Structural Analysis

Sir—In the article "Simplified Analysis of Indeterminate Frames" in your April 26 issue, I was very much pleased to read Mr. Ellis' statements concerning the so-called fundamental methods of solving statically indeterminate stresses. Since the principles themselves are often veiled by extraneous mathematics, the following very elementary illustrations may help to make their true status clear. The comparisons of methods apply primarily to deflections; the solution of statically indeterminate stresses is simply a matter of adjusting deflections and the forces that accompany them so that the deflections will satisfy all geometrical conditions and the forces satisfy all statical conditions simultaneously.

Consider the four following problems:

Problem 1—Determine the force X, Fig. 1, by means of principles of statics. The solution is evidently to apply the principle of moments, taking moments about the support; whence, $X = 2$ lb.

Problem 2—Determine the distance x, Fig. 2, by geometry. From the similar triangles ABB' and ACC', the distance x is evidently ½ in.

Problem 3—Determine the force X, Fig. 1, in some other way than by statics. If the force of 1 lb. is balanced by the unknown force X, and the lever is rotated a little way, one side will gain energy and the other side will lose energy. According to the law of conservation of energy, these two changes must be equal. Therefore, proceeding as in Problem 2: (X) (½ in.) = (1 lb.) (1 in.) and $X = 2$ lb.

Problem 4—Determine the deflection x, Fig. 2, in some other way than by geometry. Once more using the law of conservation of energy, apply a force on the left end. By statics find the force on the right end to balance it (one-half as great as the first); then find how far the first force must move to balance the energy gained or lost by the second in moving 1 in. This distance will be ½ in.

It will be observed that solution of mechanics problems by mechanics and geometry problems by geometry must inevitably require fewer operations than some roundabout substitute method such as is exemplified in Problems 3 and 4. *Problem 4 is none other than the well-known "method of work,"* stripped of all embellishment. In a structure, by the popular method of proof, the force corresponding to that at the right end would be furnished by elastic members, and would therefore be a function of the deflection; the force at the left end would then also have to be a function of the deflection, and it would be necessary to evaluate a differential equation to balance the work done at the two ends. But all this in no way alters the simple facts set forth above, and it appears that Mr. Ellis might have gone a step farther and stated that the method of work isn't even a fundamental method at all.

Probably it seems embarrassing for a mature engineer, after mastering engineering mathematics, to stoop to lowly high school geometry. Perhaps this is why it has been so persistently shunned. The fact is that there can be developed a whole subject of geometry of deflections, which, as might be inferred from the close relationships among the four problems above, follows very closely after corresponding methods of statics. For example, resembling the principle

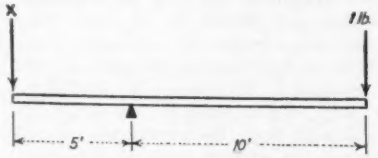
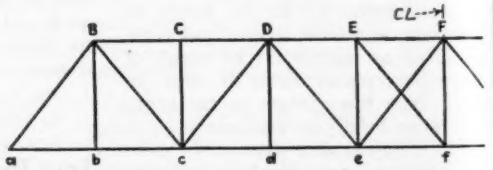


FIG. 1—FORCE x may be determined by principle of moments or by law of conservation of energy.

FIG. 2—DISTANCE x may be determined by geometry of similar triangles or by law of conservation of energy.



Panel length = 40 ft.
Height = 50 ft.
Length of diag. = 64.0 (+)

Increments of Deflection
Chords $\frac{40}{50}$ ΔL per panel
Diagonals $\frac{64.0}{50}$ ΔL constant

Member	ΔL=SL/AE	Increment		a	b	c	d	e	f
e f	0.413	0.330		1.650	1.320	0.990	0.660	0.330	
D F	0.790	0.632		2.528	1.896	1.264	0.632		
c e	0.813	0.650	Chords	1.950	1.300	0.650			
B D	0.778	0.624		1.248	0.624				
a c	0.752	0.602		0.602					
e F	0.189	0.242		0.242	0.242	0.242	0.242	0.242	
D e	0.528	0.675	Diagonals	0.675	0.675	0.675	0.675		
c D	0.474	0.606		0.606	0.606	0.606			
B c	0.666	0.853		0.853	0.853				
a B	0.539	0.690		0.690					
Deflections above F				(a) 11.044	B 7.516	c 4.427	D 2.209	e 0.572	F 0
Hangers - ΔL = 0.320 Posts ΔL = 0.033					0.320	0.033	0.320	0.033	0.320
Deflections above F					b 7.196	C 4.394	d 1.889	E 0.539	f -0.320
Deflections below a			Top		B 3.528	C 6.650	D 8.835	E 10.505	F 11.044
			Bottom	0	b 3.848	c 6.617	d 9.155	e 10.472	f 11.364

FIG. 3—TRUSS DEFLECTIONS determined by simple arithmetic and inspection of member shortening or lengthening.

of moments, there is the theorem that when a body rotates a very small amount about a point, the component in any direction of the movement of any point is proportional to the perpendicular distance from the line of that component to the center of rotation.

In figuring stresses in a truss the method of joints (usually graphical) is well suited to a truss of irregular shape, while much swifter methods are available for one of regular outline. Just as the Williot diagram is a method of joints, working progressively from one to the next, so more convenient methods can be developed for special cases. For instance, consider the middle portion of the truss in Fig. 3 held fast, while member *ce* stretches a certain amount. Then the parallelogram *caBD* will rotate about point *D*, and the various points will move up in proportion to their horizontal distance from point *D*. Or if member *cD* shortens, then the figure *caBC*, connected to the rest of the structure by the parallel links *CD* and *cd*, must move bodily upward. It is easily proved that the magnitude of this movement is as indicated. Thus, by a little simple arithmetic, the deflections of such a truss can be very quickly obtained. In the example a degree of precision was purposely used which could not possibly be equalled by graphical means. Since it was evident from inspection in which direction the changes in length of members would deflect the truss, no algebraic signs were used. All the top-chord members shorten; all bottom-chord members stretch, and diagonals alternately shorten and stretch, all contributing to downward deflection.

DAVID B. HALL,
Albany, N. Y. Bridge Designer,
April 30, 1934. State Dept. of Public Works.

Composite Roughness in Channels

Sir—W. B. McMillan's discussion (*ENR*, Feb. 22, 1934, p. 268) of the author's paper (Nov. 30, 1933, p. 652) raises some interesting questions. Both McMillan's formula and the author's formula for equivalent roughness are based on the Manning formula. No doubt your readers have been puzzled to find the reason for the difference between the formulas. The author's formula is intended to apply to channels, and in deriving it the author carefully avoided making any *a priori* assumption as to the manner in which a change of roughness affects the velocity, leaving this to be determined by the analysis. It was simply assumed that there was, in case of a channel with two degrees of roughness, a unique pair of values of n which, inserted in the two terms of the right-hand member of the author's formula (3), will give the same mean velocity as that obtained by the use of the observed or equivalent roughness n_e in the Manning formula. This, of course, is true.

EQUIVALENT ROUGHNESS AND RELATIVE VELOCITIES IN A WIDE CHANNEL WITH AND WITHOUT ICE COVER

Depth = Δ. Bottom Roughness = n_b
Surface Roughness = n_s. "Equivalent Roughness" = n_e

	Roughness Coeff.						
	Bot. n_b	Surf. n_s	Formula	R	n_e	$\frac{1}{n_e}$	Rel. Vel.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Without cover	n_b	0	....	Δ	n_b	....	1.00
2. With cover	n_b	n_b	....	Δ/2	n_b	....	.63
3. With cover	n_b	0	(a)	Δ/2	$.63n_b$	1.59	1.00
			(b)	Δ/2	0	....	∞
			(c)	Δ/2	$.50n_b$	2.00	1.26
4. With cover	n_b	$\frac{1}{2}n_b$	(a)	Δ/2	$.77n_b$	1.30	.82
			(b)	Δ/2	$.67n_b$	1.50	.95
			(c)	Δ/2	$.75n_b$	1.33	.84
5. With cover	n_b	$2n_b$	(a)	Δ/2	$1.54n_b$	.65	.41
			(b)	Δ/2	$1.33n_b$	.75	.47
			(c)	Δ/2	$1.50n_b$	.67	.42

(a) Horton: $n_e = \dfrac{(k_b n_b^{3/2} + k_s n_s^{3/2})^{2/3}}{n_b n_s}$

(b) McMillan: $n_e = \dfrac{n_b n_s}{k_b n_b + k_s n_s}$

(c) Wtd. Mean: $n_e = k_b n_b + k_s n_s$

Mr. McMillan bases his analysis on the flow in a pipe and assumes that the resulting formula can be applied to a channel. In a pipe it happens that the fraction of the hydraulic radius corresponding to a segment of the perimeter having a given n is directly proportional to the length of the segment; in other words, the hydraulic radii for sectors subtended by segments of different lengths and with different degrees of roughness are all the same. In a channel the fractions of the hydraulic radius contributed by segments of the perimeter having different values of n may not be and in general are not the same. Certainly the shallow side slopes of a trapezoidal channel do not contribute the same fraction of the hydraulic radius as an equal length of bottom perimeter.

In view of his assumptions it does not appear that Mr. McMillan's formula can safely be applied to channels, and its applicability to pipes of different diameters is doubtful. This conclusion is confirmed by the computations in the above table, which shows, in col. 6, the calculated equivalent roughness, and, in col. 8, the relative velocity in a wide channel: (1) an open channel; (2) the same channel having an ice cover with different degrees of roughness. Calculations were made by the use of the author's and McMillan's formula, also on the assumption that the equivalent roughness is the weighted mean of the roughness of the bottom and cover—i.e., $n_e = k_b n_b + k_s n_s$, where k_b and k_s are the fractions of the perimeter having roughness coefficients n_b and n_s, respectively.

Attention is particularly called to hypothetical case 3 for a channel having a cover with zero roughness. This condition cannot actually be realized, but it serves well to illustrate the manner in which both roughness and hydraulic radius are involved in the problem. For a covered channel with zero roughness of the cover, the hydraulic radius is reduced one-half. The total actual rugosity remains unchanged, but the wetted perimeter is doubled; therefore, the effective or equivalent roughness is reduced. Since, however, there is no increase in either the resistance to flow or the area of section, the velocity must remain unchanged. Using the author's formula for equivalent roughness, the velocity for such a hypothetical channel comes out, as it should, identical with that for an open channel. McMillan's formula, applied to this case, leads to the impossible result that the velocity in a covered channel with zero roughness should be infinite. The formula for weighted mean velocity indicates a velocity in such a channel considerably greater than in a similar open channel.

Mr. McMillan's Eq. (1) is a modified form of the author's equation for equivalent roughness and is easily derived therefrom. It shows that the author's formula is applicable to a channel having any number of segments with different degrees of roughness.

Voorheesville, N. Y., April 21, 1934. ROBERT E. HORTON.

Retaining-Wall Tests

Sir—Some errors in formulas occur in the articles on large retaining-wall tests as published. In article I (*ENR*, Feb. 1, 1934, p. 139) the formula should read:

$$H = \tfrac{1}{2} s h^2 \left\{ \frac{\cos\phi}{1 + \sqrt{\sin\phi\,(\sin\phi + \cos\phi\tan\delta)}} \right\}^2$$

In article III (*ENR*, March 8, 1934, p. 317, col. 3) the formula should be: $(G - \frac{1}{2}hbs_o)\tan\phi$.

KARL TERZAGHI,
Professor, Technische Hochschule.
Vienna, Austria,
May 5, 1934.

Bearing Power in Foundations

Sir—In an article written by myself and published in your issue of April 19, 1934, entitled "Determining Bearing Power in Earth Foundations," it was stated that Terzaghi, Paaswell and others disclosed the fact that a strained soil resisted the stress by two actions: its compressive strength under the bearing area and its shearing strength around the perimeter of the area. This is wrong. While these two investigators have contributed very greatly to the science of soil mechanics, it is a fact that W. S. Housel, of the University of Michigan, has been the one to develop this particular theory, and all credit is due him for it. The fact that the work described in the article was based almost entirely upon the fundamental postulates developed at the University of Michigan by Mr. Housel, and checked, at least in part, this theory, further reflects credit upon it.

H. J. SUMMERS,
Assistant Engineer,
Torrance, Calif., May 3, 1934. City of Torrance.

ENGINEERING NEWS-RECORD

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, J. I. Ballard, W. W. De Berard, N. A. Bowers.

Published by McGraw-Hill Publishing Company, Inc.
Editorial and Publishing Offices at 330 West 42d Street, New York

June 7, 1934

Volume 112, No. 23

Copyright 1934

Public-Works Funds

NOT OVER $500,000,000 of the $900,000,000 made available to the President under the provisions of the Deficiency Appropriations Bill for carrying out the purposes of the Recovery Act and the Federal Emergency Relief Act is to be used for non-federal public works; the remainder is for direct relief. This is far below the amount that should be spent if full advantage is to be taken of public-works construction as an aid to business recovery. However, the bill indirectly makes a much larger amount of money available for public works, provided the RFC is willing. The bill provides that the RFC may purchase obligations of cities, states and other political subdivisions that have received allocations of PWA funds. Such purchase will in effect turn back to the PWA for reallocation nearly 70 per cent of the allotment, the city or state taking only the direct grant of 30 per cent of the cost of labor and material. This practice has been followed in a number of instances where private banking houses have taken the bonds of municipalities after the PWA had agreed to take them as security for its loan. How much money will be made available by this procedure depends on the attitude taken by the RFC to such municipal bond purchases. If the investment-banker attitude that characterized the early days of the RFC still prevails, the amount will be small; but if a more liberal attitude is displayed, if the subject is approached in the spirit of the Recovery Act, sufficient money could be made available to take up much of the work now in the PWA files awaiting financing.

Highway Planning

THERE IS EVERY INDICATION of a large cut in federal highway funds for the fiscal year ending July, 1935. The Deficiency Appropriations Bill, introduced into the House on June 2, contains only $111,230,000 for highway work, including forest roads, roads on public lands and Indian reservations, as compared with about $500,000,000 last year. As the present construction program calls for the expenditure of the greater part of the latter by October of this year, continuation of expenditures at a rate approximating the current one in an effort to provide continuous employment for those now on highway work will largely exhaust the new appropriation by the end of the calendar year. Such a condition puts up to the highway departments the alternative of laying out their programs to spend the major part of this money next fall and winter in the hope that a new Congress will provide more funds if conditions require it, or else of bringing their expenditures down to the reduced scale and laying their program out accordingly, regardless of the effect on the immediate employment problem. The prospect is not a pleasing one. Some encouragement, however, is found in the President's recent statement to the effect that the Administration's present planning is based on the provision of sufficient funds to carry the recovery program along until Congress reassembles in January. With that support, the logical plan would be to lay out a highway program that will continue the present high rate of employment into the winter months.

Water Conservation

WIDESPREAD DROUGHT, both in this country and abroad, lays new emphasis on the need for long-range planning for the conservation of our water resources. Obviously, no amount of water conservation will prevent a drought such as is laying waste wide stretches of fertile land in the Middle West, nor will any study find justification for the construction of reservoirs to impound abnormally high streamflows, but much water that now runs to waste can be conserved and much more efficient use can be made of available supplies. Details of the reports that accompanied the President's message of June 4 to Congress on the subject of water conservation are not available as this is written, but it is obvious that he is fully conscious of the fact that any study that Congress may authorize must be broadly conceived and, in addition to the subject of flood control, navigation, irrigation, domestic supply and power development, must also include the closely related subjects of soil erosion and land use. It is to be hoped that the broad outline which he expects to present to Congress before it adjourns will be such that much of the groundwork can be laid before Congress reassembles.

Riding for a Fall

NEWS FROM WASHINGTON is to the effect that a powerful lobby of the U. S. Building and Loan League is determined to scuttle the national housing bill proposed by the President. One need not be an enthusiastic champion of the measure to see objections to such tactics. Nor need one be clairvoyant to see that by such tactics real estate interests are riding for a fall. In attempting to throttle all attempts at reform of mortgage practices, real estate interests probably are misjudging the public temper, which has recently displayed itself in wide approval of the stock-market control bill and of almost any proposal to curb the freedom of public utilities. Abuses beget regulation. And abuses have abounded in mortgage practices the country over. Too many people have been betrayed by "guaranteed" mortgage bonds and by needless losses and foreclosures to forget these abuses. The national housing bill may never be passed, but mortgage reform is coming in one form or another. Real estate interests would serve their own ends better by instituting needed reforms themselves and by cooperating with Congress constructively rather than by opposing every measure that attempts to change the status quo.

Bold Arch Building

SWEDEN, long noted for its able concrete technicians, will soon be able to boast of the second longest concrete-arch bridge in the world. This remarkable structure will span 593.5 feet over Traneberg Sound in Stockholm, thus being only 20 feet shorter than the arches in Freyssinet's famous Plougestel Bridge near Brest, France. In this country we have only one concrete arch that approaches even 500 feet—the George Westinghouse Bridge at Pittsburgh. European engineers may not be more proficient with concrete than their brothers in America (a debatable

question), but they undoubtedly exercise their knowledge more courageously. The Traneberg Sound arch is a bold structure. Like the Plougestel arches, it utilizes hollow or cellular ribs, a design not yet attempted in America. These ribs have a high width-depth ratio, in which respect they resemble the ribs of the George Westinghouse Bridge, which, design studies showed, offered advantages in economy and efficiency over square or vertically-slender ribs. Also like the Plougestel arch, the centering for the Traneberg Sound Bridge sets a high mark for construction boldness. Hingeless, rolled-section, steel arches of 565 feet, such as were used at Stockholm, present a major erection problem in themselves. Yet they were placed with the utmost simplicity by floating half-arches into place, attaching the skewback ends and raising the other ends to connection at the center on floating falsework. And finally the centering was removed by the novel Freyssinet jacking method used at Plougestel and also in this country on the Rogue River Bridge in Oregon. The Traneberg Sound Bridge, when it is opened in September, will assume a place with the notable bridges of the world. And, like all great engineering structures, it will help pave the way to even greater achievement the world over.

Uniform Traffic Code

A WELL-ROUNDED CODE of laws and practices for the safe operation of vehicles on highways is available to states and municipalities through the deliberations two weeks ago in Washington of the Fourth National Conference on Street and Highway Safety. As indicated in the outlines of conference activities published at that time and in this issue, the code is the result of long and arduous labor by the conference and its committees. Few who worked through the five days of almost continuous deliberations in Washington will recall a meeting of experts of higher attainments or of greater diligence in their conference labors. If the safety acts and signal manual that were produced do not present themselves to all as models to be followed in all particulars, it is not because of a lack of earnest effort to make them criteria of wise legislation and sound practice. This meed of praise must temper all appraisals of faults and omissions.

It is not to be considered that the laws and practices set forth by the code meet all desires—indeed it is certain that they fail measurably in brevity and simplicity—but they can be accepted as they stand as truly an enormous improvement over prevailing conditions of regulation and control in the safe use of the highway. As an improvement they put an obligation upon traffic officials to see that state and municipal legislators take action. An annual accident census that counts over 30,000 persons killed and nearly 1,000,000 injured on streets and roads leaves no excuse for delay. And regardless of hazard, no motorist can today travel from state to state and often not even from town to town, with assurance that the rules that he followed legally in one will not precipitate him into the hands of the police in the other. This intolerable condition of traffic regulation calls for immediate remedy.

The task of awakening legislative bodies to a realization of this fact rests upon state and municipal highway officials. They have to carry out their duty militantly. This they are not doing generally. Excellent work in planning and building structurally safe roads can be credited to the engineers of our modern main roads; they have now to apply engineering skill and purpose to the regulation and control of highway transport. A uniform code of traffic laws and practices set up by legislation is a vital part of their future work.

Pavement-Joint Fillers

RECENTLY reported experimentation with expansion-joint fillers for concrete pavements indicate strikingly how few usable facts we have obtained from experimental studies of this pavement element. Joint fillers have been the exasperation of paving engineers ever since paving has been written about. Trouble began with the early days of brick and stone block, persists in their use today, and now has firmly fastened on the builder of concrete pavements. Paving engineers everywhere are troubled with extrusion, lack of resilience, and climatic deterioration of joint fillers. Committees of engineering associations are investigating these problems, and inventive manufacturers are each year offering new fillers as a solution. Yet practice has not accepted any joint filler as thoroughly satisfactory.

The practical demands on a joint filler are many, particularly in concrete roadbuilding, where complaints of filler faults are most frequent. The joint filler in a concrete paving slab must almost necessarily be a structural element that can be placed as a unit and hold its true position as the concrete approaches and progresses beyond it at modern rapid concreting speeds. It must stand compression without extruding above the pavement surface, must be able to remain compressed for long periods to half or even a third of its original thickness, and must expand to its original thickness when the joint again opens—all this in cold or heat, in rain and drought. And throughout all conditions the filler must have a long life, since renewal is economically impracticable.

Far from being a minor detail of concrete pavement structure or construction, or even a cheap detail, the joint filler contributes largely to pavement integrity and expense. Until lately this fact has been rather slurred by paving engineers, and the problem of filler betterment has been attacked rather perfunctorily. Serious experimentation was neglected until recent test work by the Bureau of Public Roads and by one or two state highway departments was understaken. Even this work gives no great help. The results recently published by the Bureau of Public Roads confessedly present only a qualitative comparison, and end in the general assertion that "the perfect expansion-joint filler is yet to be developed." In effect, the question of expansion-joint fillers is as wide open as ever.

A formidable problem still confronts the highway engineer in providing this working element of his rigid pavements. To solve it, the start must be made from a new conception of the pavement joint as an articulation and of the filler as the operating element in joint movement, and not merely as a compressible zone in the otherwise rigid slab. In centering on resiliency and resilient life of joint fillers, recent experimentation is showing needed recognition of their true function in pavement. Continuation of the work offers a fruitful opportunity to the manufacturer and research engineer. He needs, however, to turn his thinking about-face from a joint element acting merely as a "filler" to a joint element acting as an articulation. With this start, well begun by the tests of the Bureau of Public Roads, a solution of the joint-filler problem can be looked for with some confidence.

CURRENT NEWS

Public Works Money and Highway Funds in Deficiency Bill

Washington Correspondence

THE NEW emergency appropriation provided in the Deficiency Appropriations Bill passed by the House of Representatives on June 4 is a pyramid that belies the figure of $1,172,000,000 which the bill actually carries. To the $899,675,000 appropriated for public works and relief, including Civilian Conservation Corps and Tennessee Valley Authority, not only must be added any sum which the President may see fit to transfer from the Reconstruction Finance Corporation's unobligated fund of two and one half billion dollars, but also an amount which may be made available specifically for public works under a provision which authorizes the RFC to buy the bonds of public bodies on projects for which the Public Works Administration has approved a combined loan and grant.

No more than $500,000,000 may be spent by PWA for public works from appropriated or transferred funds, but this figure may be more than tripled if distributed to any large extent only as grants of 30 per cent of the cost of labor and materials, leaving RFC to provide funds for the balance of the cost of such projects by the purchase of bonds.

Federal and non-federal work

Out of the $500,000,000 appropriation must come $62,500,000 for another year's work on federal projects to which PWA is committed, but apart from that Administrator Ickes proposes to distribute not less than 75 per cent, or $375,000,000 to non-federal projects. Distributed as grants which represent approximately 25 per cent of the cost of such projects, this $375,000,000 may be multiplied by four, making $1,500,000,000 if for every dollar that PWA puts up, the RFC loans three.

Another $341,000,000 may be added if RFC takes off the PWA's hands, the bonds already purchased against projects financed by combined loans and grants. It is not likely that RFC loans will reach any such tremendous total as these figures represent as about one-half of all applications approved by PWA to date are for grants only, totaling $45,000,000; but whether the municipalities sell their bonds to the RFC or in the open market, PWA money distributed as grants only will spread much further than this year when the loan portion of loan and grant allotments totaled $341,000,000. Administrator Ickes estimates that two billion of the five billion dollars of pending applications probably are worthy of consideration.

Relief operations

Authorization given to transfer RFC funds for relief needs removes any likelihood that any of the $500,000,000 earmarked as the limit for direct expenditure on public works will be sacrificed for that purpose. In addition to this $500,000,000, the appropriation also carries $100,000,000 for roads, $11,230,000 for national forest, park and public land roads and trails, $65,000,000 for public buildings, and $96,095,000 for various emergency items including a contribution of $75,000,000 to the federal land banks and $10,000,000 for repeal enforcement.

Highway appropriations

In addition to the $100,000,000 for roads in the fiscal year commencing July 1, the bill authorizes a like amount in each of the two succeeding years with a provision that in 1936 the states match 50 per cent and in 1937, 100 per cent of the total. Piqued because PWA allotted only $28,000,000 for federal postoffices and courthouses this year, Congress in reappropriating for this purpose $65,000,000 that was diverted last year to start the Civilian Conservation Corps, placed their selection in the hands of Secretaries Morgenthau and Farley from lists previously authorized by Congress, also other projects which "in their judgment are necessary to meet the special emergency needs of the public service."

Combination of Western Firms Gets Bonneville Dam Contract

Contract for the main spillway dam at the Bonneville project on the Columbia river was awarded May 29 to the Columbia Construction Co., Reno, Nev., for $8,972,650. This firm is reported to be made up of five companies comprising Six Companies Inc., builders of Boulder Dam. The J. F. Shea Co., sixth member of Six Companies Inc., was second low bidder with $9,436,500. The U. S. Engineer Department, in charge of the project, estimated the work at $7,893,192. The work involved under this contract includes channel enlargement, construction and removal of cofferdams and unwatering the working areas, foundation excavation, placing concrete and steel for the main dam, abutments and apron, cutoff walls and fishways, and bank revetment above and below the dam, and construction of levees on Bradford Island and the Washington shore. At the site the river is divided into two channels by Bradford Island. The spillway dam lies between the Washington shore and the Island, and contract for a dam across the other channel, which will contain the power house, will be let at a future date. The Bonneville project was briefly described in *ENR*, April 5, 1934, p. 441.

Building Construction Program for Mexico City Totals $3,000,000

Several important building projects are scheduled for the near future in Mexico City which probably will aggregate almost $3,000,000. These projects will feature an art theatre erected by the municipal government, a large motion picture theatre, and several office buildings to be erected on Juarez Avenue.

Court Decision Holds State Has Right to Tax City Utilities

IN A DECISION of the state supreme court on May 24, the state of Washington was held to have a constitutional right to impose a tax on the gross revenues of municipally-owned public utilities. The decision reverses a Thurston County judgment and rules that a city-owned utility must pay the tax levied against its gross revenues under the state business tax law. The rates provided for in the law are 3 per cent on the gross revenues of power and water utilities and one-half of one per cent on those of street railways. Only a few of the several hundred municipal utilities in the state have been paying under the law, many holding up payment pending the outcome of the court action, which was instituted by the city of Tacoma. There are fifteen municipal power and light plants and 139 water systems in the state.

The business tax law, enacted by the 1933 legislature to raise emergency revenue for the common schools, imposed upon municipally-owned utilities an excise tax at the same rate as was imposed upon privately-owned utilities. The provision was attacked in the Thurston County court by the city of Tacoma, with the city of Seattle intervening. The cities sought to permanently enjoin the State Tax Commission from enforcing the act against their utilities. Under the decision the municipal utilities must pay the amount of the tax which has accrued against them since the effective date of the act, or appeal to the Supreme Court of the United States.

It is estimated that the decision will cost Seattle's lighting, water and railway departments an aggregate of $384,000 for the two-year tax period.

Gas Tax Returns for 1933 Show Increase Over Previous Year

State gasoline taxes in the calendar year 1933 yielded a revenue of more than $519,000,000 as compared with $514,138,900 in 1932, according to reports collected from State authorities by the Bureau of Public Roads. This figure does not include tax returns from the Federal gasoline tax. Consumption of gasoline exceeded 14 billion gallons and was slightly less in 1933 than in the previous year. The weighted average tax rate was 3.65 cents per gallon. There was a noticeable increase in the diversion of funds to other than highway purposes and also an increase in funds allocated to local roads.

The total revenue was allocated as follows: To state highways, $277,517,371; to local roads, $111,109,158; to state and county roads, bond payments, $58,972,767; to city streets, $13,334,180; to costs of collection and administration, $2,727,801; and to other than highway purposes, $55,742,173.

All Bond Contracts and Grant Agreements Sent Out by Public Works Administration

All bond contracts and grant agreements covering loan and grant allotments to public bodies and the few loans made to private corporations have been prepared and sent out to the applicants for execution by the Public Works Administration. The total number of contracts sent out is 2,257, of which 1,900 have been signed up and returned by the applicants. Expenditure of approximately one billion dollars of public money is governed by these contracts. Administrator Ickes has signed 1,700 of those returned and the balance will receive his signature as fast as the final examination of them can be made to determine action on changes requested by applicants. A recent check-up shows that 1,300 projects are either completed, under construction, under contract or being advertised for bids.

664 projects under way

A total of 664 PWA non-federal projects are under construction at present, involving an estimated total cost of $504,856,000. This represents more than 55 per cent of the estimated total cost of the entire number of non-federal projects being built with PWA loans and grants. Completing the 664 projects will create 241,000,000 man-hours of direct employment at construction sites and probably twice as many more at the mills and factories. To date 137 PWA non-federal projects have been completed, and 263 more are ready to go into construction. These are in addition to the 664 now under way. An additional 323 projects are ready for bids.

Highway work 90 per cent along

Work under way and completed on the federal-aid highway program involved 90 per cent of the $400,000,000 PWA road fund at the close of last month, according to the Bureau of Public Roads. Employment figures have risen to a new high with 173,754 receiving direct employment on the roads on May 26. A total of 4,991 projects are now under construction, involving $264,695,000 PWA funds, and 1,515 projects, amounting to $43,023,000, have been completed.

Conservation of Water Resources Urged by President

BROAD planning for the conservation of the nation's water resources, planning that goes far beyond that visualized by Congress when on Feb. 2 it asked the President to report on a comprehensive plan for the improvement and development of the rivers of the United States, was briefly outlined in a message transmitted to Congress by President Roosevelt on June 4. Congress asked the President to provide it with information to guide it in framing legislation that will provide for the maximum amount of flood control, navigation, irrigation and development of hydro-electric power, but in this first report on the subject the President stated that any attempt to meet the requirement of Congress "automatically opens the door to all inter-related subjects which come under the general head of land and water use." This broader definition, said the President, "brings to our attention very clearly such kindred problems as soil erosion, stream pollution, fire prevention, reforestation, afforestation, marginal lands, stranded communities, distribution of industries, education, highway building, home building, and a dozen others."

The President's message was accompanied by a list of technical advisers who had served in compiling the information, a review of reports of technical subcommittees on water flow, a review of a report of technical subcommittees covering additions in the arid sections, prepared by the U. S. Bureau of Reclamation, and several reports of technical subcommittees covering various regions. The President pointed out that the time for the preparation of reports was extremely limited and that all, therefore, were based primarily on information already at hand. He added that "For the purpose of making a preliminary test I requested a wholly tentative trial selection of ten specific projects. As I had expected, the report strongly doubts the advisability of recommending these projects on the ground that any selection at this time must necessarily omit many meritorious projects which further analysis may show to be preferable." Further, he stated that it is obvious that a competent coordinating body must go over all the reports as well as reports on other projects in order to produce a comprehensive plan.

The President recommended no legislative action by the present session of Congress, but strongly recommended further study and stated that he expects before the final adjournment of this Congress to forward to it a broader outline of national policy in which the subject matter of this message will be presented in conjunction with two other subjects also relating to human welfare and security. What these subjects are was not stated in the message.

Sheppard T. Powell To Give Annual A.S.T.M. Lecture

Sheppard T. Powell, consulting sanitary and chemical engineer, Baltimore, will deliver the ninth Edgar Marburg lecture at the 1934 annual meeting of the American Society for Testing Materials at Atlantic City, June 25-29, choosing as his subject "Water as an Engineering and Industrial Material." Mr. Powell will review briefly the uses of water in engineering and industrial projects, stressing the variety of specifications required to meet the varying demands. He will outline specific requirements in different industries and discuss the advances in the art of water purification. The problem of testing forms a large portion of the lecture, especially analytical procedure. A brief survey of the current research in this country and abroad will focus attention on the potential value of petrographic, spectrographic, and other applications of analytical procedure.

Housing Bill Meets Opposition in Congress

Washington Correspondence

IF CONGRESS goes home without passing the housing bill, the responsibility will lie at the Capitol, not at the White House. That is the impression, at least, which President Roosevelt's strategy this week is designed to create. The President wants action but his supporters have to overcome not merely the inertia of a tired Congress but the opposition of the powerful United States Building & Loan League.

As this organization claims most of its strength in the House, the bill will be routed through the Senate first, and action there will be used as a lever to get it out of the House Banking Committee. Suspension of the rules during the tail end of the session will prevent a filibuster but the question is whether, under such procedure, the bill can command the necessary two-thirds vote.

The principal difficulty is that the Building & Loan League wants to preserve the existing mortgage set-up while the administration wants to reorganize it. Building and loan associations want guarantee of their deposits, and little else. Instead of mutually insuring private funds invested in mortgages, they would have the Government put up capital by buying building and loan shares. Neither do they want any federally-blessed national mortgage associations "to roam up and down the land" and cut into their business.

To permit speculative builders to participate in the program, from which they are deliberately excluded by the administration's bill, the National Association of Real Estate Boards proposes creation of a Federal Mortgage Discount Corporation to purchase at a discount of 2 per cent mortgages on new, other-than-owner occupied urban homes. For this purpose, the corporation would have a capital of $200,000,000 paid in by the U. S. Treasury, and be authorized to issue bonds or other obligations to the extent either of 15 times its capital or the principal of the mortgages owned (less 5 per cent). Such obligations would be tax exempt and guaranteed both as to principal and interest by the Government.

Mortgages which are purchased or commitment to purchase is made by the corporation prior to July 1, 1937, would be limited to 80 per cent of appraised value, thereafter to 60 per cent amortized over a period of not more than 18 years at a rate of not less than 2 per cent a year. Mortgages would not be eligible for discount on which the interest rate exceeds 6 per cent, or upon which the total cost of placement to the original borrower exceeds 5 per cent of the face of the mortgage.

At variance with much real estate opinion and for that reason particularly significant is the statement by Hugh Potter of Houston, Texas, president of the National Association of Real Estate Boards that "it would be disastrous if the financing minority with its powerful lobby should be successful in defeating this good social measure" (meaning the original administration bill).

Washington Notes

By Paul Wooton

Washington Correspondent

PWA Holds Up Housing Loan

No more funds will be advanced by PWA to the Dick-Meyer Corporation for the Woodside Housing project, Queens, pending revaluation of the land by an independent committee. The original contract approved by Administrator Ickes calls for a loan of $3,210,000 based on an appraisal of $1.53 a square foot, or a total of $863,000. Later it was discovered that in 1929 George C. Meyer, president of the limited dividend corporation, had sworn to an affidavit, for the purpose of obtaining a lower tax assessment, that the land was worth $109,000 and that it was assessed this year at $175,500.

Kick-back Investigation Broadened by Senate Committee

Senate investigation of the alleged kick-back racket on the payment of wages on federal buildings will include the scrutiny of all contracts awarded since enactment of the Bacon-Davis Act which requires payment of the prevailing rates in each community. The Committee on Education and Labor will meet next week to arrange its itinerary that will include hearings in several large cities other than Washington. As outlined by Chairman Walsh, the scope of the investigation is intended to disclose the extent to which contractors and labor unions are implicated, also to discover how energetic federal officials have been in enforcing proper execution of contracts and investigating violations. The Senate committee will endeavor to learn whether it was the intention of contractors in submitting low bids to use kick-back methods and thereby obtain contracts to the disadvantage of contractors complying with the law. In this connection, the government contracting agencies will be called upon to show whether inquiries were made into the conduct of contractors before awarding contracts to them.

Firms Are Required to Pay Fees to Only One Code Authority

Double taxation for the support of code authorities has been definitely ruled out by General Hugh S. Johnson in an instruction sent out recently to all code authorities. The order was contained in rules regarding the issuance of the new code eagles, which are now to be sent out automatically by the code authorities to all members of their industries in good standing, instead of, as originally ordered to be sent out only on application. It read: "No employer shall be liable to assessment by more than one code authority. If he is subject to more than one code his assessment shall be the one fixed by the Authority of the code under which he operates his principal line of business. If he is unable to arrive at an agreement with the Code Authority or Code Authorities as to what constituted his principal line of business, the matter shall be referred to NRA for adjustment, and the judgment of NRA shall be final."

Bids for Hetch Hetchy Pipeline Will Be Opened June 12

Bids for the construction of Bay Pipeline Crossing No. 2 in connection with the Hetch Hetchy project will be opened by the Public Utilities Commission of San Francisco on June 12. The cost of the pipeline is estimated at $2,250,000, and the entire project with trestles, submarine pipe, valves and appurtenances will involve an ultimate expenditure of $4,702,000. The pipeline will carry water from Irvington portal of the Hetch Hetchy coast range tunnels across Dumbarton Straits to the east portal of Pulgas tunnel. Construction of the pipeline, 20 miles in length, will involve 5 miles of 62-in concrete pipe, with steel lining, 20 miles of 66-in. steel pipe, and about a half mile of 76-in. steel pipe.

The water department, under the direction of N. A. Eckart, chief engineer and general manager, is making surveys for a 20-mile pipeline between Crystal Springs Reservoir in San Mateo County and University Mound Reservoir, San Francisco County. Preliminary estimates for a steel pipeline place the cost at $2,556,000. Plans have also been started for the new University Mound Reservoir and the Sunset Reservoir, these to cost approximately $1,000,000 each. Pipeline extensions within the city limits will involve an expenditure of $2,366,000.

Loan Sought for Aluminum Plant

The Standard Aluminum & Alloy Company, Chicago, has applied to the Public Works Administration for a loan of $20,000,000 for the construction of a plant for the production of aluminum in the Tennessee Valley, the plant to be supplied with cheap power from the plants of the Tennessee Valley Authority.

Ickes Names Board To Direct Building of Twin City Sewers

TO END local controversies and force immediate start of construction on the $18,000,000 St. Paul-Minneapolis sewage works, Public Works Administrator Harold L. Ickes has exercised the government's right to supervise the project by naming a board responsible for engineering and design subject to the approval of the Administrator. Work on the project has long been delayed by local controversies as to engineering services. The board consists of the following members: Chairman, Brig. Gen. Charles W. Kutz (retired), U. S. Army Engineers; Frederick Bass, dean of engineering, University of Minnesota; Darwin W. Townsend, consulting engineer, Chicago; George W. Fuller, consulting engineer, New York; and William N. Carey, state engineer of PWA for Minnesota.

At the same time the Administrator disapproved, without reflection, the proposed contract between the Board of Trustees of the St. Paul-Minneapolis Sanitary District and the firm of Consoer, Townsend & Quinlan, engineers, for consulting services on the project at fees which might have amounted to $270,000.

The Administrator's action came after prolonged negotiations between the various local interests had failed to result in settlement. PWA was forced to take the initiative when asked to approve of the contract over which the sewer district commissioners split, providing for engineering services on the project. More than a million dollars' worth of construction may be advertised and started promptly.

Procedure Outlined for Establishment of Area Labor Agreements Under the Code

Under date of May 25 NRA has issued instructions for effectuating mutual or area agreements arrived at through collective bargaining, under Article III, Section 1 of Chapter I of the Construction Code. The instructions quote from a memorandum of April 24 from Major George L. Berry, Divisional Administrator, as follows:

(1) Responsibility rests upon the employer and employee organizations to conduct all initial work leading up to such agreements.

(2) When such collective bargaining contracts for areas or regions have been consummated by the employers and employees, they must be presented to Division 3 of NRA for disposition. The first step is the setting of a public hearing which shall be held in Washington if the distance is not too great; otherwise in the leading city of the area covered by the agreement. Division 3 will ask the State Compliance Director in such area to serve the proper notice of hearing on all interested parties; also the national employers associations and national employees organizations concerned will be asked to select one person from each association directly connected with the collective bargaining contract to sit with the State Compliance Director, or to sit with the Deputy or Assistant Deputy Administrator if the hearing is held in Washington.

(3) On completion of the hearing, the records are to be transmitted to Division 3 for study and decision as to whether the collective bargaining contract comes properly within the purview of the Construction Code to a degree to justify transmission to the President for approval.

An area agreement must cover the work or part of work included in a division or sub-division of the construction industry under an approved chapter; therefore, immediate agreements may be made only in divisions covered by Chapters II to X of the Code. Attention is directed to the necessity for carefully defining the region or area in which an agreement will be effective, the boundaries of which must be justified at the hearing.

Emphasis is laid upon the development of adequate representation of both employers and employees assenting to an agreement, which assent, insofar as is possible, should be obtained from non-members of any employer or employee association participating in the bargaining. Information is requested for several past years as to the number of concerns and the number of employees, assenting to the agreement; and also data for those not assenting.

Code Authority Issues More Explanations; Agreement Reached on River and Harbor Code

Under date of May 31, the Construction Code Authority has issued twelve additional explanations of the Construction Code, numbered 9 to 20, inclusive.

Explanation 9 was issued as a result of various requests for a definition of "standard products" and as to why "the furnishing of quotations on standard products" was specifically excluded from the definition of competitive bidding under Section 1 (a), Article VII of Chapter I. It was also asked whether a general contractor is permitted, after he receives a contract, to take revised and additional figures on standard products. The explanation defines a standard product as "a product which can be purchased from a manufacturer or distributor without special specifications." Attention is directed, however, to the fact that the primary distinction in the definition of Sect. 1 (a) is as between competitive bidding and furnishing quotations. Under the Code, it is optional with the contractor whether he asks competitive bids (where such can be obtained from vendors) or satisfied his need for prices in preparing a bid for a construction project by utilizing quotations from vendors. Whether a general contractor is permitted, after he receives a contract, to take revised and additional figures on standard products is explained to be contingent on whether he has received prices by quotation, and if so, whether the terms of the quotations were binding, or the vendors free under their particular codes to requote to the contractor. The fact is pointed out that quotations on standard products are governed by codes of fair competition other than the Construction Code, and this is one reason why the Construction Code does not impose any obligations on members of the construction industry with respect to the handling of quotations.

Asked for a ruling as to the status of an architect who contracts with an owner to do the work, or takes a job on a cost-plus or time and material basis, the Construction Code Authority explained in Explanation 10 that under the facts submitted an architect is governed by the provisions of Chapter II.

Advice was requested as to whether a general contractor has the right, under Sect. 10, Art. VII to reject all bids under any sub-contract item and to invite new bids after ninety days time has elapsed, and the ruling is in the affirmative in Explanation 11.

It is ruled in Explanation 12 that this obligation to await the elapse of 90 days after the rejection of all bids before new bids are invited is not modified by inviting new sub-contract bids on parts of the work for which bids are rejected by either combining certain items previously bid upon as separate items or separating certain items previously bid upon as one item. The explanation states this does not constitute a substantial change in the plans or specifications as is contemplated in Sect. 10 of Art. VII, if new bids may be invited before the elapse of 90 days.

Asked whether a general contractor having rejected all bids on a particular project is required to invite the sub-contractors who had submitted previous bids, Explanation 13 indicates that when a situation arises whereby new bids may be invited or submitted under Sec. 10, the particular work is restored to its original status, and previous actions of the parties are not binding. Accordingly, a general contractor may invite additional or fewer sub-contractor bids in readvertising, at his own discretion.

An insurance company employing crews of three to five men, including skilled and unskilled labor, to make repairs and improvements to farms and buildings owned by the company, inquired whether it is bound by the provisions of the Construction Code as to minimum wages and maximum hours. Explanation 14 states that by engaging in this type of work, the company becomes a member of the construction industry and as such is subject to the provisions of the Code.

Explanation 15 states that an owner is not liable for a contractor's non-compliance with the provisions of the Construction Code. However, it is pointed out that this relates only to the owner's liability under the Code, and does not embrace any civil responsibility or obligation the owner may otherwise have.

Questions regarding the mechanics of submitting legitimate bids under Sec. 7 of Art. VII are still being asked. In Explanation 16 it is explained that a general contractor may not accept or use an unsealed bid.

Explanation 17 covers an important point that has been worrying many general contractors who are called upon frequently to submit an approximate estimate of the cost of a contemplated construction project, and who solicit the assistance of sub-contractors in various lines of work for approximate estimates. The question was asked whether the submission of such approximate estimates constituted competitive bidding under the meaning of the Code. In view of the fact that such estimates are not asked for at a definite predetermined time, nor covering a specific program of work definitely to be undertaken, Explanation 17 states that so long as the requests for approximate prices are made under circumstances as outlined, it does not constitute competitive bidding within the meaning of Sec. 1 (a) of Art. VII.

A business man constructing an apartment building under his personal supervision and for himself inquired whether he is bound by the provisions of the Construction Code; and Explanation 18 states that the construction work in question comes under the Code.

The Construction Code Authority was furnished with a copy of a postal-card invitation from a general contractor inviting sub-contractors to bid on all work within their line on all jobs where the trade reports listed the general contractor's name as figuring the work, and asking if this arrangement met with the sub-contractor's approval, to sign and return the attached card noting thereon the materials and trade upon which the sub-contractor would figure. This cooperation was indicated as enabling the general contractor to file the sub-contractor's name on his approved list of sub-contractors for work in his line. Explanation 19 refers to the right of the general contractor, as stated in Explanation 6 (*ENR* April 26, p. 553) to send out a general invitation *to his list of sub-contractors*, but rules that a blanket invitation along the lines quoted might constitute the inviting of an unnecessary number of bids and also run afoul of the requirements of Sec. 5 of Art. VII if the technical and financial competency of the proposed bidder had not been demonstrated to the general contractor. Accordingly, a blanket invitation so made is considered to be contrary to the letter and spirit of the Construction Code.

The Construction Code Authority ruled similarly in Explanation 20, against a blanket invitation as published by a construction news service company which carried a blanket invitation on behalf of certain general contractors to all sub-contractors who purchased the service.

Demolition of Useless Buildings Started in Chicago June 1

After five months effort on the part of the Chicago Metropolitan Housing Council, a program of demolition of useless buildings in slum areas was started June 1 with the use of relief labor. A house torn down at 2950 S. Federal St. was first of a group of 25 in the same neighborhood for which contracts have been executed with a building wrecker, who furnishes the tools, insurance and compensation liability in return for the salvage plus his bid. The contract is made between the Illinois Housing Commission and the contractor, the owner giving consent to wrecking his building. Labor is supplied and paid for by the Illinois Emergency Relief Commission.

Demolition by consent of the owner will care for only a small portion of the 1,500 dilapidated structures in the near-in area of the city which a CWA survey last winter disclosed ready for tearing down at once. Of the 5,000 houses investigated, 2,000 were found in need of major repairs if not demolished.

An attempt is being made by the Housing Council to initiate a program which will permit removal of buildings as soon as they become unfit for habitation, but state legislation must be obtained which will give additional powers of condemnation to the city building commission.

Hartford Bonds Bring Premium

A new bond issue of $2,000,000 of the Metropolitan District of Hartford County, Conn., has been sold to a group headed by R. L. Day & Co., at a price of 103.091. The bonds pay 3 per cent interest and are dated June 1, 1934, and become due serially from 1936 to 1955. The financing is for the purpose of constructing a new sewage treatment plant and intercepting sewer. The bonds are general obligations, payable from unlimited ad valorem taxes. The district, which comprises the city of Hartford and a number of neighboring towns, was formed in 1929 by a special act of the Connecticut legislature in order to administer the water and sewerage systems of the area.

A new low rate in large bond issues for cities in the United States is believed to have been set recently when the city of Albany disposed of nearly $2,000,000 coupon bonds at a net interest rate to the city of 2.6251 per cent.

Conference on Use of Models Receives National Support

The program planned for the conference on laboratory uses of models in structures and hydraulics, in connection with the meeting of the Society for the Promotion of Engineering Education in Ithaca, N. Y., June 19-21, includes 27 papers. First symposium of its kind, it has attracted the support of the leaders in model study work from every part of the country. For most of the papers listed below, there are to be several written discussions. The titles of the papers, while not complete, are definitive of the ground to be covered.

New Goals—W. E. Wickenden, Case.
The Conference—Fred L. Plummer, Case.
Similitude—Roy W. Carlson, California.
Deformeter Method—Hale Sutherland, Lehigh.
Photoelastic Method—Thomas H. Evans, Yale.
Types of Models—H. J. Gilkey, Iowa State.
Hydraulic Models—R. W. Powell, Ohio State.
Hydraulic Research at
Iowa University—F. T. Mavis.
Vicksburg—H. D. Vogel.
Maine University—W. J. Sweetser.
Cornell University—E. W. Schoder.
Loaded Models—J. C. Rathbun, C.C.N.Y.
Photoelasticity in Schools—Max M. Frocht, Carnegie.
Dynamic Lateral Loads—L. S. Jacobsen, Stanford.
Deformeter Uses—J. T. Thompson, Johns Hopkins.
Dam Analysis—J. L. Savage, Bureau of Reclamation.
Hydraulics Instruction—E. W. Schoder, Cornell.
Dam Models—C. W. Hubbard, Worcester Poly.
Pipe-Line Flows—L. J. Hooper, Worcester Poly.
Suspension Bridges—George E. Beggs, Princeton.
Photoelastic Research—G. B. Karelitz, Columbia.
Concrete Arches—Carroll L. Mann, Jr., Raleigh, N. C.
Torsional Problems—Bruce Johnston, Lehigh.
Filter Sands—G. M. Fair, Harvard.
Water Systems—T. R. Camp and H. L. Hazen, M.I.T.
Teaching Trends—Clyde T. Morris, Ohio State.

The conference is under the chairmanship of Prof. Fred L. Plummer of Case School of Applied Science, Cleveland.

PWA Offers Cleveland Loan for Sewers with Certain Restrictions

The city of Cleveland has been offered a PWA loan of $6,498,000 and a grant of $2,492,000, with certain restrictions, for construction of sewers. The government demands that the city pass ordinances prohibiting the discharge of industrial wastes into the sewer systems that might damage the sewer lines or disposal plants and require rebuilding of these units before the life of the loan expires. This stipulation is reported to be aimed at the Industrial Rayon Corporation's operations. For some time the city has been in a controversy over the building of a sewer solely to serve this plant. Another stipulation of the government loan would be that in the event of further default of any bonds of the city, a sewer rental tax would be placed upon sewer lines financed by PWA to protect the government loan. This stipulation is reported to be distásteful to the city administration, but will probably be accepted. During the past week conferences have been held in an effort to compromise some of the loan requirements.

Personal

H. ALDEN FOSTER, on May 15, resigned as associate hydraulic engineer in the U. S. Geological Survey, where he had been engaged on studies of flood magnitudes and frequencies for the Mississippi Valley Committee of the Public Works Administration. Mr. Foster is now at North Platte, Nebraska, where he will be resident engineer for the firm of Parsons, Klapp, Brinckerhoff & Douglas of New York, consulting engineers for the Platte Valley Public Power and Irrigation District.

GEORGE HAINGRAY, for twelve years assistant superintendent of the Medina, N. Y., water works department, has been appointed superintendent succeeding James Boyland.

S. M. SMITH, formerly bridge engineer for the St. Louis County Highway Department, has returned to the Wabash Railway where he has accepted the position of engineer of design.

WALTER M. SMITH, acting chief engineer of the Illinois Division of Waterways for the past year since the resignation of the late L. D. Cornish, has been appointed chief engineer.

R. S. BLOMFIELD, draftsman and computer during the construction of the Safe Harbor (Pa.) dam and power house, has been reengaged by the Safe Harbor Water Power Corp. in connection with additions to the hydro station.

WM. R. CHAMBERS has been named chief engineer of the geology division of the Tennessee Valley Authority, Knoxville, Tenn.

JOSHUA D'ESPOSITO, PWA state engineer for Illinois, has been made resident engineer for PWA on the $42,000,000 project of the Sanitary District of Chicago. The PWA Board of Review, Messrs. Mead, Storey and Kutz, which reported recently, is to continue to function on call as Mr. D'Esposito may request.

C. M. OSBORN, city manager, Wilmette, Ill., has been appointed state PWA engineer for Illinois to take the position left vacant when Joshua D'Esposito was transferred to take charge of the Sanitary District project.

WILLIAM L. AUSTIN, for the past ten years in charge of the street laying out department in the engineering forces of the city of Boston, retired from service on May 31 after 51 years of duty in the municipality. He came to Boston from Portland, Maine, in 1883, and retired on account of having reached the age of 70.

JOSEPH V. HOGAN, chief engineer and assistant to the president of the Arundel Corporation, Baltimore, for the last five years, has been elected president of the company to fill the vacancy caused by the recent death of Joseph J. Hock. Mr. Hogan has been connected with the company for 15 years.

CHARLES R. GOW, state engineer for public works in Massachusetts since Aug. 15, 1933, and president of Warren Brothers Company, paving engineers and contractors, Cambridge, Mass., has resigned the former post to devote himself to private business.

RALPH A. BARRY, who for the past twenty years was chief engineer of the Jobson Gifford Co., is now associated with the H. H. Sherwin Co., contracting engineers, Graybar Building, New York.

WALTER FLEMING, formerly an engineer with the central division bridge department of the Ohio Highway Commission, has been named assistant division engineer in charge of bridges for Division No. 11, with headquarters at New Philadelphia.

JOHN F. SKINNER, former Rochester, N. Y., deputy city engineer, has been appointed to the committee on water resources of the State Planning Board. Mr. Skinner was in charge of Honeoye Lake developments and other water projects throughout the state.

CHARLES H. FOSDICK, who has been connected with state and highway county departments for 34 years, has been named superintendent of highways of Erie County, N. Y., succeeding George C. Diehl, recently resigned.

Obituary

STUART A. DEMING, road contractor of Bellingham, Wash., died suddenly in that city on May 22 at the age of 45.

HENRY G. LAMBURN, for many years a prominent contractor at Waltham, Mass., died at his home in that city on May 29 at the age of 75. He retired from business eleven years ago.

ALBERT C. GOERIG, active in the construction industry on the Pacific Coast for the past fifty years and head of the Goerig Contracting Co., Seattle, died at his home there on May 27.

HARRY H. HUDSON, drainage engineer of Pittsfield, Ill., died May 28 at Little Rock, Ark., from injuries received in an automobile accident in that city the previous day.

CAPT. ROBERT A. BLAIR, construction quartermaster at Fort Lewis, Wash., for the past three years, died at the Fort on May 21 at the age of 54. Captain Blair entered the service of the government as a civil engineer in 1904, serving in that capacity until 1917, when he was commissioned army construction quartermaster. He came to Fort Lewis from Fort Riley, Kansas.

ALFRED T. BROWN, president of the Highway Materials Co., of Clayton, Mo., died on May 22 at the age of 52, following an illness of two years. For a number of years he had been prominent in Illinois and Missouri road construction circles. In 1924 the Missouri State Highway Commission awarded him a certificate of honor in recognition of his efforts on behalf of the passage of the state bond issue legislation that year.

EDWARD M. HEWLETT, pioneer electrical engineer, who retired as consulting engineer of the General Electric Co. in 1931 after 41 years of service, died in Schenectady on May 24 after a short illness. He was 68 years old. Mr. Hewlett was born at Cold Spring Harbor Sept. 14, 1866. From 1884 to 1890 he was general manager and civil engineer of the Cascade Town Improvement Co. of Cascade, Colo. He constructed the first carriage road for tourist parties to the summit of Pike's Peak. Mr. Hewlett is credited with many improvements in the electrical engineering field, and designed the control ap-

paratus for the locks at Panama Canal.

F. G. PROUTT, chairman of the Memphis Board of Water Commissioners, died in that city May 27 at the age of 64, following an illness of three months. A native of Canada, Mr. Proutt came to Memphis in 1897 from Malden, Mass., where he served in electrical and utility fields. He was once superintendent of the old Memphis Power & Light Co. In 1906 he was manager of the Jackson, Miss., Power & Light Co., returning to Memphis in 1908. He served in the engineering field during the World War and was made chairman of the city water board at Memphis in 1920, serving during the extensive building and enlargement projects and until his death. He was consulting engineer for several communities in the surrounding states, and superintended the installation of water and lighting plants in many cities of the Mississippi Valley.

SOCIETY CALENDAR

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting at Cornell University, Ithaca, N. Y.; conferences, June 19-21, regular meetings June 21-23.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Vancouver, B. C., Canada, July 11-14.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, annual conference, St. Louis, Oct. 15-17.

NEW YORK STATE SEWAGE WORKS ASSOCIATION, spring meeting, Jamestown, N. Y., June 15-16.

AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, annual midyear conference, Hampton Beach, N. H., June 18-19.

THE FIFTH INTERNATIONAL CONGRESS OF SURVEYORS, to be held in London July 18 to July 21, will be attended by Col. James Gordon Steese, U.S.A., retired, of Tulsa, Okla., and Earl F. Church, associate professor of photogrammetry, Syracuse University, officially representing the United States government. The congress will be under the direction of the Chartered Surveyors' Institution of England. Both technical and general subjects pertaining to surveying, planning, quantity surveying and valuation will be discussed.

NEW ENGLAND WATER WORKS ASSOCIATION held a one day session on May 23 at Manchester, N. H. as guest of the Manchester Water Works staff. The group, 150 strong, made an inspection of the municipal plant and of the water properties, including two existing reservoirs and a third under way.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, Buffalo chapter, elected Timothy N. McCormick president at a recent meeting. Other officers are Stuart S. Neff, vice president; Thomas L. Mayer, financial secretary, and Arthur H. Weaver, treasurer. At the meeting Harry H. Brown and Samuel J. Whitehead, engineers in charge of the construction of the Grand Island bridges, gave talks on engineering phases of that project, and Walter N. Z. Taylor, secretary of the Buffalo Planning Board, outlined the proposals of the board for the development of Buffalo's waterfront.

CONSTRUCTION STATISTICS OF THE WEEK

JUNE STARTS OFF with the record total engineering construction awards for the year, a $40,201,000 week. This week's total for public awards, $37,817,000, is also the record for the year. The state and municipal total of $26,514,000 is the highest for the year and the federal total, $11,313,000, is the second highest week this year. These figures bring the average week to date up to $24,398,000 and the gain to date over last year to 47 per cent.

Gains were in waterworks, from $743,000 last week to $7,242,000 this week; in sewerage from $635,000 to $1,236,000; in streets and roads from $7,406,000 to $8,310,000; in bridges from $1,644,000 to $2,640,000; earthwork, irrigation and drainage from $1,463,000 to $10,412,000. Commercial and industrial buildings both dropped, commercial buildings to $604,000 and industrial buildings to $871,000.

Large awards include Saratoga Springs Authority bath houses, N. Y., $713,000; highway awards by Massachusetts, $943,000, by Indiana, $540,000, by Montana, $672,000 and by Alabama, $562,000. The Maiden Creek Mechanical Filter Plant at Reading, Pa., $635,000, and pipe award by Milwaukee, Wis., $5,244,000, are responsible for the high waterworks total. In Oregon, the Yaquina Bay bridge was awarded by the State Highway Department, $1,358,000 and the main spillway dam for the Bonneville Dam on the Columbia River was awarded by the federal government, $8,973,000, plus cement, $606,000. In California, the Oakland-Broadway low level tunnel including electric, mechanical and ventilating equipment was awarded at $3,879,000.

New financing for the week consisted solely of municipal bond sales which total $5,802,000. Included in this figure are Hartford, Connecticut, sewerage bonds, $2,000,000, and the Alameda and Contra Costa County Joint Highway District Tunnel bonds, $2,378,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average June 1933	Prev. 4 Weeks	Week June 7 1934
Federal Government	$562	$3,158	$11,313
State and municipal	9,402	14,158	26,504
Total public	$9,964	$17,316	$37,817
Total private	10,871	5,589	2,384
Week's total	$20,836	$22,905	$40,201
Cumulative to date: 1933	$380,901,000	1934	$561,182

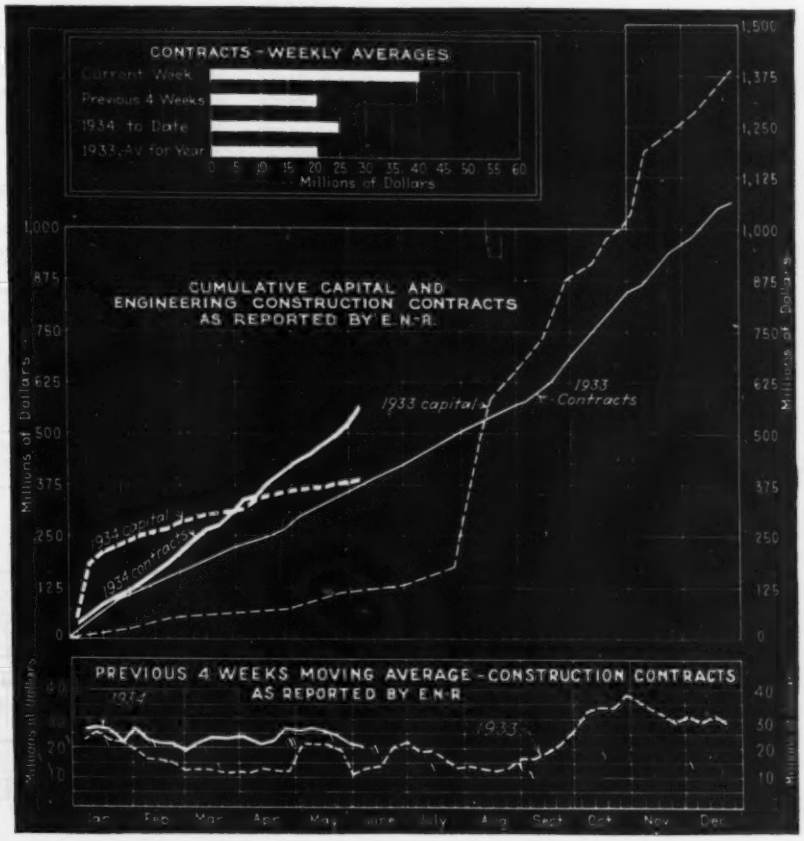
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1934	Week June 7	Cumulative
State and municipal	$5,802	$134,879
PWA allotments, S&M	.....	185,103
RFC loans, S&M	.....	1,349
Corporate issues	.....	13,542
PWA allotments, private	.....	50,417
Total, Non Federal	$5,802	$386,300
PWA allotments Federal Constr.	.....	49,461
Total new capital	$5,802	$435,751
Cumulative to date: 1933	$131,560	1934 $386,300

NOTE: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

INDEX NUMBER

E.N.-R.- Cost	1913 = 100	1926 = 100	E.N.-R.- Volume	1913 = 100	1926 = 100
June, 1934	199.61	95.95	May, 1934	101	44
May, 1934	199.61	95.95	April, 1934	109	48
June, 1933	163.41	79.02	May, 1933	103	45
1933 (Av.)	170.18	81.80	1933 (Av.)	102	45
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56
1931 (Av.)	181.35	87.17	1931 (Av.)	220	96.5



BUSINESS SIDE OF CONSTRUCTION

May Contract Average Lower; Cost Index Stationary

ENGINEERING construction in May at $116,743,000 represents an increase in private awards and a recession in public contracts. The average of $23,349,000 per week is slightly below the average week for this year but 19 per cent ahead of May last year on dollar volume. The volume index drops 7 per cent from April and 2 per cent below May, 1933, due to the higher cost index.

Weekly federal awards at $3,144,000 are about half of last month, but three and a half times a year ago. Street and road awards practically equal last month and are almost 400 per cent ahead of last May. Commercial buildings are well ahead of last month and last May, while industrial buildings dropped behind. Public buildings are slightly below last month, but well ahead of last year.

Territorially, New England, South and Middle West show gains over last month and substantial gains over last year. Far West gains over last month but cannot duplicate May, 1933, when the San Francisco-Oakland Bay bridge and Metropolitan Water District of Southern California tunnel awards established an all time high. Middle Atlantic and West of Mississippi, while well ahead of last year, both drop below April of this year.

New capital

PWA financing this month consisted entirely of adjustments in previous allotments and changes from loans and grants to grants only. The net result was a withdrawal of part of the PWA funds earmarked for state and municipal construction. During the last half of the month RFC purchases of municipal bonds were announced which partly offset the PWA funds withdrawn. Municipal bond sales continued at an average of $5,000,000 per week. This is below the April rate, below the average week to date, but 17 per cent ahead of the first quarter average.

Material notes

Cement—Portland cement production for April was 6,544,000 barrels and shipments from mills 6,498,000 barrels as reported by the Bureau of Mines. This is a gain in production of 56.4 per cent and of 31.3 per cent in shipments over April, 1933. The ratio of production to capacity climbed to 29.6 in April compared with 18.9 a year ago and 23.0 in March.

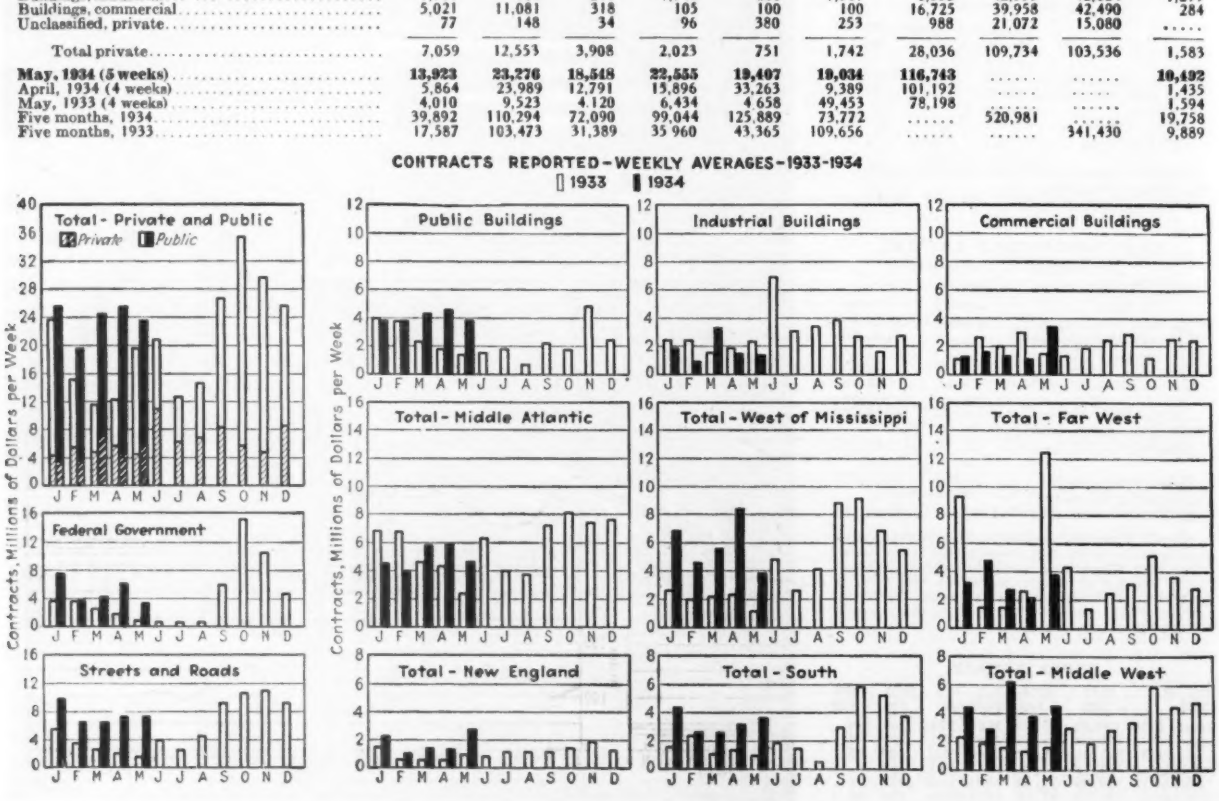
Steel—The operating rate of steel companies having 98.1 per cent of the steel capacity of the industry was 56.1 per cent of capacity for the week ending May 28. This compares with an average for the 5 weeks of May of 55.9 per cent of capacity and is an increase of 3.5 per cent over the immediately preceding week as reported by

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN MAY, 1934

Five Weeks—Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States May 1934	United States Five Months 1934	United States Five Months 1933	Canada May 1934
Public Works										
Waterworks	681	165	334	679	711	939	3,509	19,728	39,813	64
Sewers	434	378	1,120	4,305	664	160	7,061	22,939	7,088	58
Bridges, public	498	409	1,096	1,981	1,955	2,489	8,428	42,622	48,000	322
Earthwork and waterways	406	263	1,094	1,479	1,100	4,679	9,021	48,195	20,411	135
Streets and roads	1,980	2,972	8,569	8,334	8,927	5,815	36,597	162,539	63,891	5,609
Buildings, public	2,642	6,356	2,302	2,719	4,345	1,604	19,968	87,101	54,881	2,435
Unclassified, public	223	180	125	1,035	954	1,606	4,123	28,123	3,810	286
Total public	6,864	10,723	14,640	20,532	18,656	17,292	88,707	411,247	237,894	8,909
Federal gov't. (included in other classifications)	722	2,039	2,407	1,747	3,312	5,493	15,720	105,972	52,133	.....
Private										
Bridges, private	.....	421	3,257	79	11	.....	3,768	6,351	3,142	.....
Buildings, industrial	1,961	903	299	1,743	260	1,389	6,555	42,353	42,824	1,299
Buildings, commercial	5,021	11,081	318	105	100	100	16,725	39,958	42,490	284
Unclassified, private	77	148	34	96	380	253	988	21,072	15,080	.....
Total private	7,059	12,553	3,908	2,023	751	1,742	28,036	109,734	103,536	1,583
May, 1934 (5 weeks)	**13,923**	**23,276**	**18,548**	**22,555**	**19,407**	**19,034**	**116,743**	.....	.....	**10,492**
April, 1934 (4 weeks)	5,864	23,989	12,791	15,896	33,263	9,389	101,192	.....	.....	1,435
May, 1933 (4 weeks)	4,010	9,523	4,120	6,434	4,658	49,453	78,198	.....	.....	1,594
Five months, 1934	39,892	110,294	72,090	99,044	125,889	73,772	.....	520,981	.....	19,758
Five months, 1933	17,587	103,473	31,389	35,960	43,365	109,656	.....	.....	341,430	9,889

CONTRACTS REPORTED—WEEKLY AVERAGES—1933-1934



the American Institute of Steel Construction, Inc. April bookings of fabricated structural steel reported by the American Institute of Steel Construction were the best enjoyed during the past year and a half. They were 111 per cent larger than for the same month last year, 46 per cent better than the average monthly bookings during the last quarter of 1933 and 33 per cent larger than the average during the first quarter of 1934. April shipments were 31 per cent larger than for the same month last year.

Lumber—Lumber shipments reported by the National Lumber Manufacturers' Association average 191,000,000 feet for the first three weeks in May for which revised figures are reported. A longshoreman's strike which tied up lumber operations on the Pacific Coast during the second half of May caused a drop both in production and shipments. Early figures for the week ending May 26 show a drop in shipments to 169,658,000 feet. Prior to May 12, new business booked, production and shipments all were running well ahead of last year. The last three weeks of the month saw a decline in this high rate of activity.

Labor

Employment reported by the Bureau of Labor for March on public and private building-construction projects not aided by public works funds showed an increase in March of 12.4 per cent over February in number on payroll and an increase of 16.3 per cent in payrolls. The average hourly earnings reported is $0.79. Employment on federal projects during March as reported shows 254,898 wage earners of which 141,243 are on public roads. The amount of payroll for March is $13,890,127, man-hours worked, 26,402,331 and average earnings per hour $0.526. The value of material orders placed is reported to be $24,949,285. On non-federal projects 25,109 wage earners are reported, payrolls totalling $1,036,417, man hours 1,612,304, average earnings per hour $0.643 and value of material orders placed $12,659,564. Waterworks and sewerage leads with 7,376 wage earners, railroad "construction" is second with 7,036, building construction third with 6,190, streets and roads fourth with 4,081 and to "miscellaneous" is credited 426 wage earners. All figures are subject to revision.

Employment index from Pennsylvania Department of Labor and Industry for February, 69.8, showed a decline in employment on construction from that reported in January, 81.2, and a decline from the February index a year ago, 80.3, using the 1933 average as 100. The corresponding payroll index shows 72.3 for February, 1934, compared with 80.8 for January and 82.0 for February, 1933.

Industrial fatalities in April reported by the New York State Department of Labor total 121 workers of which 13, or 11 per cent, are charged to the construction industry.

Wage rate controversies continue. The Rochester carpenter's strike reported last month was settled May 16 on a compromise when the Carpenters' Union accepted $1.05 an hour for an 8-hour day and a 5-day week. The carpenters had asked $1.20 and hour and a 30-hour week. The rate before the strike was 90 cents per hour. TERA workers in Rochester were also out on strike in May. The skilled workers returned to work on the 15th on a temporary basis. The settlement of the carpenters strike provides a new prevailing wage which affects TERA carpenters. The Welfare Commissioners of City and County were working on a budget plan to pay increased allowances for large families.

The carpenters strike called May 1 in Washington and reported last month is unsettled as we go to press. Union carpenters have rejected by a vote reported to be 536 to 466 a proposed compromise wage of $1.25 per hour for an 8-hour day and are holding out for $1.37½ per hour, a 6-hour day and 30-hour week. Several firms and contractors are reported to have signed at $1.37½ an hour and a 6-hour day. The moving of Calvert St. Bridge and construction of buildings for Interstate Commerce Commission, Department of Labor and the Auditorium are held up. The situation on these federal buildings is further complicated by refusal of the contractors to remove plasterers of Bricklayers, Masons and Plasterers' International Union, who are on the jobs from which plasterers of the Operative Plasterers and Cement Finishers' International Association are on strike.

More than 100 bricklayers went on strike May 28 at the new state hospital at Mount Morris, N. Y. They are asking $1.25 per hour. Their present rate is $1.12. On May 3 the Regional Labor Board handed down a decision that the Niagara Falls Builders' Association shall pay members of local 322 of the United Brotherhood of Carpenters and Joiners of America the basic wage rate of $1 per hour beginning April 30. Both parties agreed to arbitrate. The union asked $1 an hour as of April 23, the builders' association was willing to pay $1 per hour begining June 1. On May 18, truck drivers on the Lee boulevard project, Arlington County, Virginia went on strike for a pay rise but returned to work without any change in rate. Prevailing wages are being paid by the contractor. At Boston, May 21, 50 riggers and men working on pile drivers on the Fore River bridge went on strike protesting their wage of $.65 an hour and demanding $1.00. Settlement depends on the degree of skilled labor represented. Maximum for skilled labor is $1.20 per hour, minimum unskilled $.50 per hour.

At Philadelphia, 3000 painters, paper hangers, decorators and wood workers went on strike for $1 per hour but several hundred were ready to return to work. Before the strike vote was taken employers offered $.75 per hour with an increase to $.85 on October 1 and $1.00 on May 1 next. It was reported that scattered employers had acceded to demands that $1 an hour rate be inserted in the Painters' Code for the Philadelphia district.

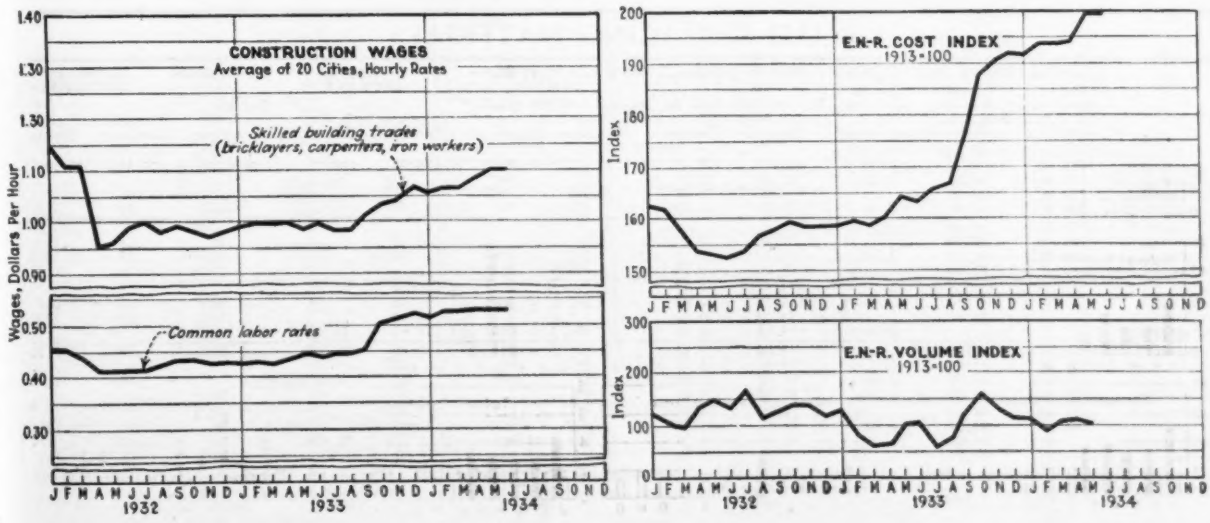
ENR Cost and Volume Index

The *Engineering News-Record* Construction Cost Index for June remains unchanged at 199.61. The Volume Index drops back to 101 on a 5-week's month.

Beginning with this issue these indexes are reported for a 1926 = 100 base as well as the previous base, 1913 = 100.

INDEX NUMBER

E.N.-R.-Cost	1913 = 100	1926 = 100	E.N.-R.-Volume	1913 = 100	1926 = 100
June, 1934	**199.61**	95.95	**May, 1934**	**101**	44
May, 1934	199.61	95.95	April, 1934	109	48
June, 1933	163.41	79.02	May, 1933	103	45
1933 (Av.)	170.18	81.80	1933 (Av.)	102	45
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56
1931 (Av.)	181.35	87.17	1931 (Av.)	220	96.5



CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE

	PORTLAND CEMENT — Per bbl., carload lots, f.o.b. city, including cost of bags			SAND AND GRAVEL — Per ton, carload lots, f.o.b. city			CRUSHED STONE — Per ton, carload lots, f.o.b. city		CRUSHED SLAG — Per ton, carload lots, f.o.b. plant		CONCRETE — Ready Mixed 1:2:4, 50c.y. or more, delivered
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.79	$2.54	$2.34	$2.31	$2.31	$1.64	$1.69	$1.92	$1.80	$1.80	$9.00
Baltimore	2.66	2.41	2.21	1.80‡	2.00‡	1.25‡	1.90‡	2.00‡	2.25	2.25	7.75
Birmingham	2.55	2.30	2.10	1.75	1.75	1.40	.85	.85	.90	1.15	5.20
Boston	2.72	2.47	2.27	1.50	1.50	1.10	1.50	1.50	.....	.....	6.50
Chicago	2.60‡	2.85‡	2.40	1.60‡	1.60‡	1.64‡	1.92‡	1.92‡	.....	.....	.....
Cincinnati	2.57	2.32	2.12	1.30	1.30	1.20	1.80	1.80	.....	.....	6.70
Cleveland	2.45	2.20	.....	1.55	1.55	1.45	1.60	1.60	1.75	1.75	8.85
Dallas	2.45	2.20	2.00	1.35	1.35	1.10	2.25	2.20	.....	.....	6.35
Denver	3.60‡	3.40‡	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.25	2.00	1.80	1.15	1.05	.98	1.08	1.08	1.30‡	1.30‡	6.00
Kansas City	2.50	2.25	2.00	.65	.65	.65	1.25	1.30	.....	.....	7.00
Los Angeles	2.90	2.62	.....	1.90	1.90	1.40	1.90	1.90	.....	.....	6.70
Minneapolis	2.85	.....	2.40	1.00ᵖ	1.00ᵖ	.25ᵖ	1.00	1.00	.....	.....	7.00
Montreal	.....	1.70	.....	.....	1.60	1.45	.....	1.25	.....	.....	.....
New Orleans	2.47	2.22	.....	1.70	1.70	1.40	.....	.....	.....	.....	7.75
New York	2.90‡	2.65‡	.....	1.50†ᵃ	1.50†ᵃ	1.00†ᵃ	1.75†ᵃ	1.85†ᵃ	.....	.....	8.00
Philadelphia	2.60	2.35	.....	2.00‡	2.25‡	1.80‡	1.75‡	2.00‡	1.75‡	1.75‡	8.25
Pittsburgh	2.45	2.20	1.60	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.25	1.25	7.00
St. Louis	2.42	2.17	.....	1.85‡	1.85‡	1.85‡	1.75‡	1.75‡	.75§	.75§	7.50
San Francisco	2.00	1.80	1.50	1.35	1.35	1.35	1.50	1.50	.....	.....	6.84
Seattle	2.95	2.70	.....	1.50†	1.50†	1.50†	.....	.....	.....	.....	5.75

*Includes 40c. per bbl. for bags, 10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. ᵃBarge lots alongside dock. ᵖf.o.b. plant.

CURRENT MILL PRICES CEMENT TO DEALERS, CARLOAD LOTS, F.O.B. MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.65	$1.60	Ironton, Ohio	$1.60	$1.55	North Birmingham, Ala	$1.75	$1.70
Buffington, Ind	1.60	1.55	Iola, Kans	1.70	1.65	Richard City, Tenn	1.85	1.80
Crestmore, Calif	1.72	.....	La Salle, Ill	1.60	1.55	Saginaw, Mich	1.65	1.60
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.60	1.55	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.60	1.55	Mason City, Ia	1.70	1.65	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Norfolk, Va	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans	1.70	1.65	Northampton, Pa	1.65	1.60	Wyandotte, Mich	1.60	1.55

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME

	STRUCTURAL CLAY TILE — PARTITION — Per M, lots of 2,000 pieces or over, delivered			STRUCTURAL CLAY TILE — LOAD BEARING — Per M, lots of 2,000 pieces or over, delivered			BRICK — Per M, in quantity, delivered		LIME — Per ton, in paper, carload lots delivered		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$84.27	$89.87	$168.40	$189.50	$243.20	$277.90	$13.22	$13.50	$17.50	$12.10	$12.10
Baltimore	75.00	80.00	150.00	170.00	210.00	250.00	14.00	17.00	16.00	14.00	18.00
Birmingham	84.25	90.00	156.00	180.00	215.00	242.00	15.00	22.50	2.00§	1.25§	1.75§
Boston	85.30	91.15	171.00	193.50	239.60	273.40	14.50	17.00	21.20	15.46	3.62§
Chicago	66.00	70.40	96.80	.....	.....	.....	10.20	11.20	18.00	12.80	12.80
Cincinnati	84.65	84.65	163.00	163.00	205.25	228.25	17.50	17.50	15.97	12.48	.....
Cleveland	62.50	66.50	124.50	149.50	188.00	214.75	17.50	17.50	19.60k	16.40k	2.65k§
Dallas	74.75	80.00	156.50	156.50	199.75	228.00	13.50	28.00	15.50	14.50	.....
Denver	78.50	88.00	141.50	166.50	196.00	225.00	11.50–15.50	21.00–30.00	30.00	22.00	.....
Detroit	69.50	74.10	139.00	185.70	229.90	284.65	12.00	13.00	20.00	20.00	16.00
Kansas City	63.50	66.00	120.00	160.00	165.00	198.00	12.50	18.00	.60‡ₒ	.50‡ₒ	2.50§
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	77.00	84.00	143.00	165.00	173.00	240.00	13.10	21.00	25.50	21.00	21.00
Montreal	.....	110.00	.....	.....	260.00	.....	15.00	21.50	23.00	13.00	.....
New Orleans	58.40	62.30	116.90	159.20	194.60	.....	14.00	.....	16.60	12.95	.....
New York	84.00	90.00	135.00*	193.30†	238.80†	295.60†	14.00	.....	20.80	16.00	20.80
Philadelphia	85.90	89.30	167.40	200.80	243.20	301.10	15.00	18.00	16.35	11.25	10.75
Pittsburgh	72.65c	77.45c	145.20c	164.60c	180.50c	206.25c	17.50	22.00	16.69	14.10	16.66
St. Louis	62.00	65.00	120.00	165.00	187.00	214.00	15.00	18.00	.48‡	.38‡	2.10§
San Francisco	84.00	94.50	225.00	.....	.....	.....	15.00	18.00	22.50	21.50	2.05ₒ
Seattle	84.00	95.00	180.00	.....	.....	.....	15.00	16.00	30.00	25.00	3.00§

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl. kLCL. ₒPer bbl. 180 lbs. cLess 5% cash 15 days.

ROAD SURFACING MATERIALS

	PAVING BRICK AND BLOCKS — Granite per M, lots of 50,000, 4x4x8 in., f.o.b. city	Brick per M, 3x8½x4 in., carload lots f.o.b. city	Wood per sq.yd., 3½ in., 16-lb. treat, f.o.b. city	PAVING ASPHALT — Per ton, less than 80 penetration, f.o.b. city: Tank car	Drums	ASPHALT BINDERS—FLUXES — Per gal., 80-300 penetration, f.o.b. city: Tank car	Drums	CUTBACK ASPHALT — Per ton, f.o.b. city: Tank car	Drums	ROAD OILS — Per gal., f.o.b. city: Tank car	ASPHALT EMULSION — Per gal., f.o.b. city: Tank car	Drum
Atlanta	$100.00	$35.00	$2.25	$18.20	$23.41	$0.0728	$0.09898	$20.45	$27.22	$0.0728	$0.105	$0.105
Baltimore	125.00	44.00	2.25	17.00	22.00	.07	.095	.08†	.115†	.....	.....	.....
Birmingham	125.00	24.00	.....	18.00	23.00	0.778	.1028	.082†	.112†	.....	.06	.....
Boston	100.00	34.00	2.40	18.00	23.00	.075	.10	.085†	.12†	.075	.09	.125
Chicago	138.00	42.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cincinnati	100.00	37.00	.....	17.40	21.40	.09	.....	18.00	.....	.07	.08	.11
Cleveland	100.00‡	36.00	2.77	18.50	22.70	.0725	.085	.075†	.0875†	.0475	.09	.1025
Dallas	.....	25.00	.....	17.60	24.20	.0575	.082	.....	.....	.0575	.15	.....
Detroit	.....	35.50	.....	19.67*	24.87*	.....	.....	17.00	22.50	.....	.....	.....
Kansas City	.....	35.00	2.75	16.00	22.00	.0675	.1005	.09	.13	.065	.08	.09
Los Angeles	.....	50.00	.....	12.00	16.00	.....	.....	14.00	.....	.042	.06	.12
Minneapolis	.....	.....	2.50	18.10	24.60	.098	.098	21.75	34.55	.048	.....	.....
Montreal	.....	100.00	.....	14.00	19.66	.07	.093	19.00	26.50	.07	.125	.155
New Orleans	100.00	35.00	.....	14.50	18.50	.065	.09	.07†	.10†	.....	.....	.....
New York	135.00§	50.00	2.64	17.00	22.00	.07	.095	.08†	.115†	.....	.085	.12
Philadelphia	100.00	45.00	2.02	15.00	20.00	.06	.....	.07	.10	.06	.....	.....
Pittsburgh	115.00	40.00	.....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	100.00	35.00	2.00	19.50	24.50	.0775	.1075	.0875	.1175†	.04	.09	.125
San Francisco	.....	50.00	.....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04	.0575	.1175
Seattle	.....	47.50	.....	18.00	23.85	18.00	23.10	15.00	.....	.03	.1925#	34.20#

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudez, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½in. #Per ton §4x5x9-in. Av. ᵃMexican.

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE Per 100 lb., carload lots	REINF. BARS Per 100 lb., ¼-in. billet, carload lots	RIVETS Per 100 lb., ½-in. structural carload lots	WIRE NAILS Per 100 lb., base, carload lots	SHEET PILING Per 100 lb., base, carload lots	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES Per 100 lb., carload lots: Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$2.00	$2.10	$1.95	$2.60	.....	$36.375	$35.00	.....	$2.55	$2.40	$1.90	$3.55
Chicago	1.90	2.10	3.10	2.60	$2.25	36.375	35.00	$34.00	2.55	2.40	1.90	3.55
Pittsburgh	1.85	1.90	3.00	2.60	2.15	36.375	35.00	34.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—LOCAL PRICES F.O.B. WAREHOUSE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¼ in., base price: New billet	Rail steel	EXPANDED METAL LATH —Per 100 sq.yd., carload lots— Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING —Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq.yd.	SHEET PILING Per 100 lb: base price
Atlanta	$3.34	$2.17	$2.02	$19.50	$22.50	$1.60	$1.21	$0.151	$2.45
Baltimore	2.90	2.70	2.50	18.50	24.00	1.46	1.12	.137	2.65
Boston	3.57	3.13	2.98	21.00	25.00	1.50	1.14	.142	2.50
Chicago	3.60	2.43	....	20.50	24.00	1.46	1.12	.137	2.00
Cincinnati	3.30	3.10	3.10	25.01	29.50	1.44	1.11	.135	....
Cleveland	3.06	3.10	2.37	20.00	22.00	1.44	1.11	.135	....
Dallas	4.00	3.13	2.98	24.50	26.50	1.70	1.27	.161	2.985
Denver	3.92	3.66	....	23.00	27.00	1.70	1.27	.161	....
Detroit	3.30	2.635	2.635	18.50	21.50	1.48	1.13	.139	2.165
Kansas City	3.75	2.53	2.63	19.00	20.00	1.54	1.17	.145	2.65
Los Angeles	2.95	2.80	....	23.00	27.50	1.90	1.40	.18	2.50
Minneapolis	3.50†	2.82†	2.67†	20.50†	24.00†	1.58	1.20	.149	2.55§
Montreal	3.25	3.00	2.80	....	....	....	....	....	3.30
New Orleans	....	....	....	19.50	23.00	1.58	1.20	.149	....
New York	3.42	2.67	2.52	20.50	24.00	1.48	1.13	.139	2.48
Philadelphia	2.055	2.34	2.19	18.50	22.00	1.44	1.11	.135	2.28
Pittsburgh	1.85‡	1.90‡	1.80‡	19.10‡	21.90‡	1.44	1.11	.135	2.15
St. Louis	3.49	2.96‡	2.81‡	15.75 & 18.50	21.50	1.46	1.12	.137	2.59
San Francisco	....	2.50	2.20	23.00	28.00	1.90	1.40	.18	2.45
Seattle	3.55	3.50	....	....	....	1.90	1.40	.18	....

†F.o.b. City. ‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis.

PAINTS AND ROOFING SUPPLIES

	WHITE LEAD Per 100 lb. keg in oil, f.o.b.	READY-MIXED PAINT Per gal., drums, f.o.b.: Graphite*	Aluminum†	Ferric Oxide‡	ROOFING SUPPLIES Carload lots, f.o.b. factory: Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta	$11.50	$1.60	$3.10	....	$1.74	$2.45	$2.70	$ .36	$23.40
Baltimore	11.00	1.40	2.25	$1.90	1.70	1.60	1.80	.28	24.00
Birmingham	11.50	2.35	2.35	1.85	2.25	2.10	....	.35	23.00
Boston	11.00	1.60	2.50	.04½x	2.15	3.30	3.30	.4266	20.00
Chicago	11.00	1.85	2.25	1.25	1.43	1.34¼	1.34¼	.23	20.00
Cincinnati	11.00	1.40	3.00	1.55	2.40	2.25¼	2.25¼	.36	25.00
Cleveland	11.00	1.65	2.35	.....	1.43	50.00°	50.00°	.39	19.00
Dallas	12.00	1.80	2.41	.....	3.15½	2.56	2.47	.36	34.20
Denver	11.75	2.55	.....	.....	2.17	3.00	3.00	.50	30.00
Detroit	11.00	1.55	2.35	1.30	1.60	2.35	2.50	.37	27.00
Kansas City	11.12½	1.65	2.20	1.45	1.75	1.85	2.15	.33	26.75
Los Angeles	10.00	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	11.12½	.....	.....	.....	1.60	1.51¼	1.51¼	.2925	23.10
Montreal	9.40	1.70	3.45	1.65	2.00	2.62	2.02	1.40§	1.52§
New York	11.00	1.70	2.35	1.48	1.60	1.51¼	1.51¼	.232	20.00
Philadelphia	11.00	1.50	2.10	1.50	1.43	1.34¼	1.34¼	.29	20.00
Pittsburgh	11.00	1.05	1.95	.80	2.00	1.75¼	1.75	.35	24.50
St. Louis	11.00	1.85	2.25	1.25	1.50¼	1.41¼	1.41¼	.24	20.00
San Francisco	10.75	1.80	2.65	1.10–2.00	1.83	3.04	.....	.45	26.00
Seattle	10.75	.....	1.92	.....	3.10	4.50	.....	.50	27.60

*New Jersey State Hwy. Spec. 120M. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. °Per ton. §Per 100 lb. ¼Per roll, 65 lb. xPer lb.
Note: Red lead dry, same as white lead in oil, red lead in oil 50c higher.

MISCELLANEOUS ITEMS

	WINDOW GLASS Discounts from latest jobbers list, Sept. 15, 1928 Single or Double Thickness: A quality	B quality	EXPLOSIVES Per lb. dynamite delivered 50-lb. cases Gelatin: 40%	60%
Atlanta	85%	85%	$0.215	$0.2375
Baltimore	88%	90%	.19	.21
Birmingham	88%	90%	.105	.120
Boston	88–10–5%	90–10–5%	.1625	.1775
Chicago	87%	89%	....	....
Cincinnati	.....	.....	.27	.29
Cleveland	85%	87%	.19	.205
Dallas	88%	90%	.155	.17
Denver	84@ 5%	86@ 5%	.1575	.1725
Detroit	87@10%	89@10%	.237	.255
Kansas City	89@10%	89@10%	.17	.19
Los Angeles	90%*	90@40%*	.1725†	.1925†
Minneapolis	87%	89%	.17	.185
Montreal	.....	.....	.1875	.2125
New Orleans	88%	90%	.19	.22
New York	89%	91%	.22	.235
Philadelphia	90%	92%	.215	.24
Pittsburgh	86%	88%	.105	.12
St. Louis	87%	89%	.13	.145
San Francisco	90%	90@30%	.1575	.1775
Seattle	90@10%	90@20%	.1525	.1675

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal.

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York:	
Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.90
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	19.50
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, 60 deg., in drums, f.o.b. works, per 100 lb.	1.65
Soda ash, 58%, in bags, per 100 lb.	1.25
Sulphate of aluminum, in 100 lb. bags per ton	27.00
Sulphate of copper, in bbl., per 100 lb.	3.85

PILES

Prices, per linear foot, short leaf pine, with bark on, f.o.b., New York; delivered from barge, 1½ ro 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.11	$0.155
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.15	.20
12 in.—2 ft from butt	6 in.	60 to 69 ft.	.16	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
14 in.—2 ft. from butt	5 in.	85 to 89 ft	.305	.442

RAILWAY TIES Prices f.o.b., per tie, for carload lots:		6 In. x 8 In by 8 Ft	7 In. x 9 In: by 8½ Ft.
Boston	Oak, untreated	$1.00	$1.35
	Pine, untreated	1.00	1.35
	Pine, creosoted	1.45	2.00
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	....	1.00
	White oak, untreated	.75	1.50
Birmingham	White oak, creosoted	1.40	1.45
	Southern pine, untreated *6x8x8'6"	1.00*	1.20
	Southern pine, creosoted	1.20*	1.40
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.78
Los Angeles	Fir, untreated	.57	.80
	Fir, creosoted	1.75	2.50
Philadelphia	Red oak, untreated	1.00	1.50
	Red oak, creosoted	1.20	1.85
	White oak, untreated	.90	1.35
St. Louis	Red oak, untreated	.88	1.30
	Red oak, creosoted	1.25	1.85
San Francisco	Sap Pine or cypress, untreated	.75	1.20
	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.35

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton, f.o.b. 6 in. and over b. & s. class B and heavier, C/L lots*	VITRIFIED SEWER PIPE Per foot, delivered, standard 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONC. SEWER PIPE Per ft., delivered; ASTM Spec. C 14-24 12 in.	24 in.	WROUGHT STEEL PIPE Full std. weight. Discounts from standard list or delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 9c.; ⅜ in., 12c.; 1 in., 17½c.; 2 in., 37½c.; 2½ in., 59c.; 3 in., 77c.; 4 in., $1.10; 6 in., $1.94. 1 to 3 in., Butt Weld Black	Galv.	2½ to 6 in., Lap Weld Black	Galv.
Atlanta	$40.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.55	$1.60	47%	40%	45%	37%
Baltimore	43.50	.33	.58	2.60	5.25	100.00	170.00	.75	2.00				
Birmingham	36.00	.25	.45	1.625	.....	85.00	.....	.45	1.60	53.225%	42.205%	§54.45%	§43.429%
Boston	45.50	.231	.4455	2.025	5.945	60.10	101.00	.49	1.85	$7.62-34.29	$9.49-42.71	$47.51-83.69	$59.53-104.86
Chicago	44.00	.35	.675	2.25	5.125	120.00	200.00	.675	2.25	.....	.....	.....	.....
Cincinnati	43.00	.224	.432	1.89	5.74	64.29	.....	.40	1.40	57.33%	46.31%	58.55%	47.53%
Cleveland	44.50	.231	.4455	1.845	5.535	47.25	72.00	.536	2.102	58.4%	48.4%	60.6%	49.6%
Dallas	48.00	.27	.486	1.944	.....	160.00	229.00	.46	1.57	67.5%	58.5%	65%	57.5%
Denver	56.00	.23‡	.415‡	1.73‡	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	44.50	.294	.567	2.25	5.125	100.00	150.00	.....	.....	54%	42.3%	52.6%	41.8%
Kansas City	46.00	.38	.575	1.95	3.95	120.00	180.00	.....	.....	.....	.....	.....	.....
Los Angeles	44.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	53.57%	43%	53%	42.51%
Minneapolis	46.50	.24‡	.432‡	1.728‡	4.35‡	65.00	120.00	.50	1.33	$7.80-35.12	$9.67-43.55	$32.08-74.98	$38.21-90.70
Montreal	.....	.....	1.02	3.64	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Orleans	42.00	.25	.45	1.62	.....	50.00	.....	.45	1.65	.....	.....	.....	.....
New York	43.00	.35	.675	2.83	7.48	.....	.....	.55	2.00	.....	.....	.....	.....
Philadelphia	41.50	.28	.54	1.80	.....	135.00	210.00	.....	.....	56.65%	45.63%	57.88%	46.86%
Pittsburgh	46.00	.217‡	.418‡	1.80‡	5.43‡	46.00	82.00	.75	1.75	64%	55%	63%†	56%†
St. Louis	43.80	.27	.486	1.944	3.96	85.00	172.00	.90	2.28	55.796%	44.76%	57.021%	46.0%
San Francisco	44.00	.265	.477	1.908	5.22	105.00	175.00	.....	.....	52.4%	63.4%	51.1%	64.6%
Seattle	45.50	.35	.63	2.52	.....	84.00	200.00	.50	1.60	60.3%	51.3%	63.3%	52.3%
Burlington, N.J. (base)	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

*Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. †3½ to 6 in. ‡f.o.b. §3½ to 6 in.

LUMBER AND TIMBER

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR Per M ft. b.m., carload lots f.o.b. All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. 1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10 S4S	3x12 Rgh	6x12 Rgh.	12x12, Rgh.	LONG LEAF Y. P. Per M ft. b.m., C/L lots, f.o.b., merchantable grade up to 20 ft. 2x12, Rgh.	12x12, Rgh.
Atlanta	Southern Pine	$20.00	$21.00	$23.00	$19.50	$22.00	$23.00	$28.00	.....	.....	$38.50	$40.00
Baltimore	Southern Pine	27.00	28.00	32.00	31.00	31.00	34.00	41.00	.....	.....	57.00	60.00
	Douglas Fir	30.00	31.00	33.00	31.50	32.50	33.00	34.00	$32.00	$33.00	.....	.....
Birmingham	Long Leaf	21.50	22.50	23.50	19.50	22.50	23.50	39.50	38.50	.....	42.25	40.25
	Southern Pine	21.50	22.50	22.50	18.50	21.50	22.50	27.75	27.75	27.75	.....	.....
Boston	Southern Pine	33.50	35.25	39.00†	40.25†	58.00‡	63.00‡	76.00‡	.....	.....	76.00	76.00
	Douglas Fir	31.25	33.50	38.25	40.25	40.75	41.50	44.00	44.00	44.00	.....	.....
Chicago	Southern Pine	29.00	30.00	35.00	31.00	32.50	34.50	45.00	.....	.....	54.00	58.00
	Douglas Fir	30.50	31.50	33.25	31.50	32.50	45.00	40.75	41.75	41.75	.....	.....
Cincinnati	Southern Pine	31.50	31.50	31.50	31.00	31.00	34.00	40.00	.....	.....	.....	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	47.50	47.50	50.00	.....	.....
Cleveland	Southern Pine	28.50	29.50	31.50	28.00	30.50	31.50	45.00	42.00	.....	.....	60.00§
Dallas	Southern Pine	36.00	37.80	39.60	41.40	37.25	37.25	52.50	.....	.....	57.00	67.50
	Douglas Fir	37.00	37.00	39.00	39.00	39.50	41.30	56.25	66.15	61.65	.....	.....
Denver	Douglas Fir	.....	39.00*=	43.50*	43.00*	43.00*	44.50*	44.50*	49.00*	56.00	.....	.....
Detroit	Southern Pine	28.00	29.50	31.50	28.50	31.00	33.00	36.00	.....	.....	33.00	45.25
	Douglas Fir	.....	.....	.....	.....	.....	.....	42.25	45.25	45.25	.....	.....
Los Angeles	Douglas Fir	31.00	32.00	31.50	30.00	30.00	30.00	34.50	34.50	34.50	.....	.....
Minneapolis	Western Pine	49.50*	47.00*	43.50*	41.00*	41.00*	41.00*	53.25*‡	.....	.....	.....	.....
	Douglas Fir	46.50*	47.00*	42.75*	38.00*	38.00*	40.00*	49.75*	50.25*	53.25*	49.50*‡	.....
Montreal	Spruce	36.00	36.50	30.00	30.00	32.00	34.50	36.00	.....	.....	42.00†	.....
	Douglas Fir	47.50	47.50	42.75	51.25	51.25	57.75	.....	.....	.....	.....	.....
New Orleans	Southern Pine	26.45	27.70	32.70	27.45	30.45	31.70	43.70	.....	.....	45.20	52.45
	Douglas Fir	28.00	30.00	33.00	28.00	32.00	33.50	37.50	.....	.....	.....	.....
New York	Southern Pine	36.50*	37.75*	39.75*	35.25*	38.50*	39.75*	47.75	.....	.....	78.50*	77.25*
	Douglas Fir	44.75*	43.00*	43.50*	44.00*	40.00*	41.75*	41.75	40.00*	40.00*	.....	.....
Philadelphia	Southern Pine	27.50	28.50	30.50	27.25	29.00	30.25	35.00	.....	.....	66.00	64.00
	Douglas Fir	.....	.....	35.50	35.50	35.00	35.00	35.00	35.00	35.00	.....	.....
Pittsburgh	Southern Pine	26.50	27.75	32.75	29.25	31.75	32.75	41.50	.....	.....	57.50	57.50
	Douglas Fir	33.50	34.50	34.50	33.50	34.00	34.25	46.25	46.25	46.25	.....	.....
St. Louis	Southern Pine	38.00*	39.00*	41.00*	37.50*	40.00*	40.50*	53.50*	.....	.....	62.00*	73.50*
	Douglas Fir	.....	.....	.....	.....	.....	.....	56.50*	57.00*	57.50*	.....	.....
San Francisco	Douglas Fir	18.00‡	19.00‡	18.00‡	17.00‡	17.00‡	17.50‡	21.00‡	11.00‡	21.00‡	.....	.....
Seattle	Douglas Fir	22.50	21.50	21.50	21.00	22.50	22.50	20.00	20.00	22.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P. §Norway Pine. ▲Northern Pine. ‡Douglas fir. =Native. ‡At ship's tackle.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.50/.75	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.45
Birmingham	1.00	1.00	1.00	1.12½	1.00	.30	.30
Boston	.90/1.30	.70/1.17½	1.20	.90/1.17½	.90/1.62½	.40/.70	.40/.70
Cincinnati	1.27½	1.02½	1.20	1.07½	1.27½	.45	.40
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.12½	1.25	.72	.72
Dallas	1.10	1.00	1.12½	.75	1.25	.40	.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½	.....	.50	.50
Detroit	1.25	1.00	1.25	.75/.95	1.25	.50	.50
Kansas City	1.32½	1.12½	1.12½	1.12½	1.37½	.60 & up	.62½ & up
Los Angeles	1.00	.90	1.20	.90	1.00	.50	.60
Minneapolis	.90/1.20	.75	.90	.75	.90	.40	.50
New Orleans	1.00	.75	1.00	1.00	1.25	30./.40	.30/.40
New York	1.50	1.42½	1.65	1.50/1.56½	1.50	.82½	.82½
Philadelphia	.75/1.20	.60/1.20	1.00/1.20	.75/1.20	.60/1.20	.30/50	.30/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.35/.50	.35/.50
St. Louis	1.50	1.25	1.47	1.35/1.47	1.50	.78½	.35/.78½
San Francisco	1.50*	1.10	1.37½	1.12½	1.25*	.75	.62½
Seattle	1.20	.90	1.25	1.12½	1.20	.60	.60
Montreal	1.10	.55	.75	.75	1.00	.30	.25

Skilled Ave: (Bricklayers, Carp., Ironworkers) $1.1008. Common Ave. $0.5343 *6-hr. Day